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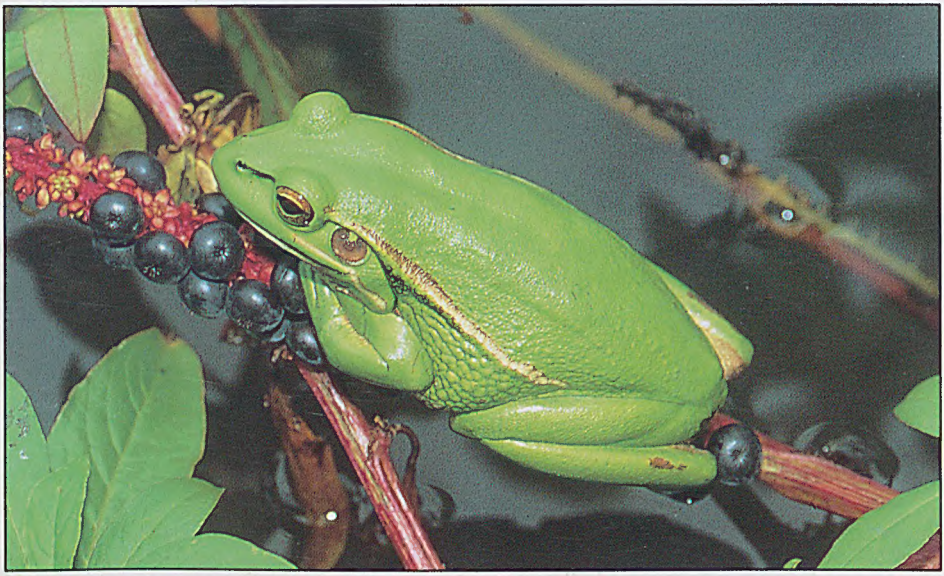

Green and Golden Bell Frog (*Litoria aurea*) female from Shoalhaven Heads.
See paper on page 2 (photo: G. Daly)

Green and Golden Bell Frog (*Litoria aurea*) male from Shoalhaven Heads.
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HERPETOLOGICAL NOTES

ERRATA:

The contents page for volume 24 No.2 of Herpetofauna should have included the following:

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OBSERVATIONS ON THE GREEN AND GOLDEN BELL-FROG *LITORIA AUREA* (ANURA: HYLIDAE).

Garry Daly
c/- North Nowra PO 2541

ABSTRACT

Green and Golden Bell-frogs are seasonally active and have been observed from September to early May. They are diurnal, bask while resting on emergent aquatic vegetation, and adult frogs are often associated with cumbungi (*Typha domingensis* and *T. orientalis*) swamps. Spawn is laid amongst aquatic vegetation in the shallow water of long standing or permanent ponds and the eggs hatch within three days. Spawning occurs in December, January and February, the month in the Shoalhaven, which the area receives, on average, the most rainfall. In the Shoalhaven tadpoles grow to 80 mm in total length (27 mm snout/vent length), have benthic habits and a dark green/brown dorsal colour. Metamorphosis can take from 2 to 11 months. Metamorphlings measure from 24 to 29 mm snout/vent length. Predation of tadpoles and eggs by the exotic mosquito fish (*Gambusia affinis*) is regarded as one cause for the Bell frog's decline. Adults were observed to spawn in fish free ponds but no adults or eggs were observed in an adjacent pond inhabited by mosquito fish. Descriptions of several sites utilised by extant populations of *L. aurea* are given. Seasonal activity patterns and sexual dimorphism are detailed.

INTRODUCTION

The Green and Golden Bell-frog has recently declined in population and has been listed on the NSW National Parks and Wildlife Service amended Schedule 12 as a threatened species. Tyler (1992) indicates that this species is common and it's status is secure. This is in stark contradiction to it's inclusion on the NSW National Parks and Wildlife Service amended Schedule 12 as Threatened. Thirty five years ago the Green and Golden Bell-frog was common in NSW (Cogger 1960).

The distribution of the Green and Golden Bell-frog (*Litoria aurea*) is from Tyaharah Nature Reserve, Byron Bay NSW (M. Fitzgerald pers. comm.) in the north to Orbost Vic (Barker and Grigg 1977) in the south. The species no longer appears to occur on the ranges of NSW (pers. obs.), but a population did exist on the southern tablelands (around Canberra, NSW Wildlife Atlas No 2, Osborne, 1990, 1992) and northern tablelands (Cogger 1993). Osborne (pers. comm.) has not seen these frogs in the Canberra area since 1980. Most currently known populations in NSW occur within several kilometres of the coast.

Mahony (1993) has not recorded this species on the central coast since 1979, but the Australian Museum was presented with one specimen from this area in 1992 (Robinson 1993), and Wellington (pers. comm.) observed adults during 1994 at Wyong, Avoca and Ravensworth. A population was observed near Musselbrook during 1994/95 (pers. obs.).In the Illawarra/Shoalhaven region this species has been recorded by the author from six localities. The status of all populations warrants monitoring.

This species prefers permanent water, either ponds or sluggish backwaters of creeks and rivers, particularly where complex vegetation occurs around the edges (Courtice & Grigg 1975).

The cause of the decline of *L. aurea* is unknown but it is possible that the introduced mosquito fish may prey on the eggs and tadpoles of this frog (Mahony 1993). The present study investigates aspects of *L. aurea*. Descriptions are given of adult habitat and oviposition sites, and comments are made on this species status and management considerations.

METHODS

Four sites (A, B & C and D) were examined that possessed breeding aggregations of *L. aurea*. These sites were in the Illawarra district of NSW and were inspected from February 1994 to January 1995. Day and night inspections occurred. Nocturnal searches were conducted using 100 watt spotlights. Site A and B were 10 kilometres south-east of Wollongong and sites C and D 12 kilometres north-east of Nowra. The vegetation, lithology and the presence or absence of mosquito fish (*Gambusia affinis*) were noted. Collection and maintenance of tadpoles were standardised as much as possible. Techniques employed during collection and transportation of egg masses/tadpoles and the counting of tadpoles will be outlined elsewhere (Daly in press). Egg masses were collected at sites A and D.

Eight spawns were laid in 'culture', ie amplecting frogs were collected and maintained in plastic bags or polystyrene boxes until they oviposited. The containers were orientated so that the water depth varied from 0-50 mm. Tadpoles were raised in a variety of tanks which ranged in volume from fibreglass pools (c 25 cubic metres) spas and polystyrene boxes.

RESULTS

Site A occurs in Wollongong approximately 400 metres from the sea. This site has ephemeral cumbungi swamps and a 10 by 10 metre patch of Swamp She-oaks (*Casuarina glauca*). Bell frogs use adjoining gardens some 300 metre distance from the dam/swamps as refuge sites. Earthworks during late 1994 drained one swamp and provided a large settling dam. Frogs colonised the new dam and spawned in the ephemeral swamps and dam. This site was used by Ms van de Mortel (Wollongong University) for a post graduate study. She recorded twenty six frogs at this site at one time, eleven pairs of amplecting frogs were collected and seven spawned. Counts of five masses ranged from 4124-6178 eggs. Amplecting pairs were located on the 25th December 1994 and the 5th and 8th January 1995 and the 13th February 1995 (van de Mortel pers. comm.). Water and air temperatures for the 25th December were 22°C.

During January 1993 site B was inspected. This site, a natural coastal freshwater pond is approximately two kilometres to the south of site A and contained tadpoles and recently metamorphosed individuals. The animals congregated in a plunge pool at the end of a series of pipes. A small, 4 metre canal between the pipes and the pond was thickly vegetated with waterprimrose (*Ludwigia peploides*). The only open water occurred immediately below the mouth of the terminal pipe. The swamp was populated with mosquito fish. A small number of fish were seen in the open water near the pipe. Metamorphling *L. aurea* were observed sitting on plastic soft drink bottles floating in the plunge pool. Dr R Goldingay inspected the site in February 1994 and found several adult Bell frogs. These adults were located in cumbungi some 300 m from the above stormwater outlet. No tadpoles were observed in the plunge pool during November 1994. The area had been burnt and the aquatic vegetation was reduced to a large extent. It is probable that animals from site A and B represent one population that utilise a number of breeding sites.

L. aurea spawned at Nowra on the 12th and 13th of February 1994 after intense rain. One hundred and nine millimetres of rain had been recorded over the two previous days. (Shoalhaven Starches). The air temperature on the nights of the 12th, 13th, 14th and 15th were 19-21°C (Shoalhaven Starches). Two ponds, sites C and D were utilised by calling males. Both ponds had dried out during the previous months and were fish free. A total of twenty male frogs were observed around the edges of these ponds.

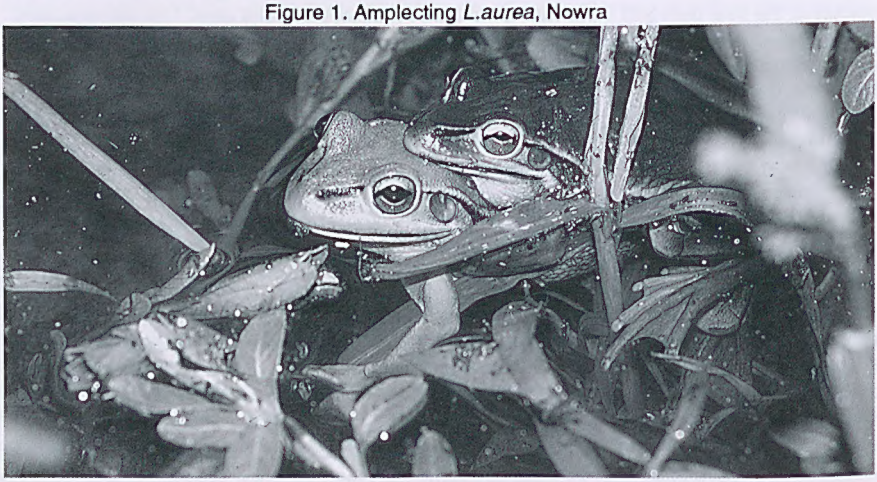
Site C was a man made dam 30 m x 35 m with a depth of about 1.5 m that had been constructed about two years previously. There was very little aquatic vegetation around the dams periphery and the nearest cumbungi (*Typha* spp) was 200 m distant. Thirteen males were observed at this dam for two consecutive nights (12th and 13th February 1994) but none were observed on the 15th. The distribution of these animals was not regular and the majority were associated with patches of knotweed (*Polygonum* sp).

No females or spawn were observed at this pond but, reinspection one month later revealed *L. aurea* tadpoles which were observed at night using a 100 watt spotlight. The tadpoles were situated on the bottom of the pond at a depth of about one metre and were approximately 50 mm in total length. The Tortoise (*Chelodina longicollis*) was observed in this pond.

Site D was artificial and was 15 m x 15 m with a depth of 0.5 m. The aquatic vegetation in this dam was water primrose and was surrounded by kikuyu grass (*Pennisetum clandestinum*), with one clump of blackberry (*Rubus vulgaris*) nearby. Seven male *L. aurea* were observed over two consecutive nights calling from the shallow edges of the dam. No frogs were seen during daytime inspections.

This pond was inspected on the nights of the 12th, 13th & 15th February 1994. On the first night seven male frogs were located. On the second night what appeared to be the same frogs were located in the same position which they had occupied on the previous night. On the 15th February only one male was observed. On the 13th February one amplecting pair and two spawns were observed (Figure 1) in water that was approximately 80 mm in depth. The female was a uniform light green colour dorsally. This pair was captured and maintained in a polystyrene box overnight where they spawned. The two spawns did not appear to be associated with the amplecting pair and almost certainly were laid on the night of the 12th.They were laid in shallow (>100 mm) water and were loosely attached to aquatic vegetation. The eggs hatched in three days. Of the 5279 eggs laid 441 did not hatch.

Figure 1. Amplecting *L.aurea*, Nowra



Ten metres from site D was another pond D_1. This pond was permanent, had well vegetated margins (with waterprimrose) and contained exotic Mosquito fish (*Gambusia affinis*) and Goldfish (*Carassius auratus*). No Bell frogs were observed in or calling from this pond on the 12th ,13th, or 15th February.

Several weeks later (March) the area received additional rain and flooded to the extent that the ponds at site D joined. Mosquito fish and goldfish moved into pond D and subsequent inspection of this pond in late March revealed no tadpoles despite being netted numerous times with a fine meshed prawn net. Site D_1 had an overflow canal that was linked to flood mitigation ditches.

Coomonderry swamp lies one kilometre to the east of site D and is bordered by both farmland and native vegetation. Part of this swamp lies within Seven Mile Beach National Park. Inspection of this swamp during December 1993 revealed two groups of calling males located among several species of aquatic plant of which the most dominant were cumbungi and

spikerush (*Eleocharis* spp). It is probable that animals from sites C and D represent a population which centres on Coomonderry Swamp.
On the opposite side of this swamp is coastal woodland which forms part of Seven Mile Beach National Park. Survey work within the woodland was conducted by Mr M. Murphy who found *L. aurea* in swamp mahogany (*Eucalyptus robusta*)//blackbutt (*E. pilularis*) forest at night. The dominant understorey plant in this area was sawsedge (*Gahnia sieberana*). On twelve occasions between January and March adult frogs were observed (Table 1), although weekly surveys were carried out between December 1993 and April 1994. No frogs were heard calling from this section of the swamp. The vegetation in the swamp at this locality consisted predominantly of spikerush.

Table 1 Observations of active *L. aurea* at Seven Mile Beach National Park

Date	2.1.94	10.1	17.1	2.2.94	3.2.94	12.2	13.2	16.2	20.2	2.3.94	3.3.94
No.of Frogs	2	1	2	1	4	2	1	1	1	1	1

Combining results of sites, amplexed adult males averaged a snout to vent length of 67 mm , range 61-75 mm (N=12) , females 76 mm, range 66-87 mm (N=12). Spawns laid in culture range from 4124-6178 and average 5121 (N=6). Tadpoles reached a total length of 80 mm (27 mm snout/vent length) and metamorphs ranged from 24-29 mm in snout to vent length.

DISCUSSION

Examination of the above sites indicates that *L. aurea* will utilise constructed ponds/dams for spawning. This is consistent with Greer's (1994) statement that breeding in ponds can occur within five months of their construction. Green and Golden Bell-frogs have attributes that allow the species to colonise new areas rapidly. They disperse over cleared areas and roads (pers. obs.) and can move 1.5 kilometres within a single night (White pers. comm.). It has the second highest fecundity recorded for any species of Australian frog (Daly in press).

Given the option, *L. aurea* will avoid breeding in ponds that possess mosquito fish. This may indicate that adults can detect the presence of this fish. Mosquito fish will nibble novel objects such as human hands (pers. obs.). If they nibble adult frogs then the frogs may abandon the site. The only site examined where *L. aurea* tadpoles coexisted with mosquito fish (site B) possessed a large amount of aquatic weed. This weed may have made the area less suitable for mosquito fish by reducing the amount of sunlight from reaching the water or the weed may have provided hiding sites for the tadpoles. The recently metamorphosed Bell Frogs at this site indicate that a limited amount of recruitment had occurred.

Merrick and Schmida (1977) give the following account of the mosquito fish. "Mosquito fish were introduced to Sydney in 1925, Brisbane in 1929 and WA in 1934. It is a native to the Gulf of Mexico frequenting shallow warm slow moving waters. It is live bearing and can breed to pest proportions very rapidly. Large populations congregate among aquatic vegetation near the banks. It is pugnacious, attacks other fish by nipping at their fins, can withstand a wide range of temperatures (3-41°C), oxygen levels and salinities and can breed very rapidly. It is considered to be a competitive threat to native fish." No native fish is live bearing, has the colonising ability of or occupies the niche exploited by *Gambusia* (pers. obs.).

In times of flood *Gambusia* disperse and readily colonise ponds and dams (pers. obs.). This species is most abundant in the warmer coastal areas and has the highest population densities in the shallows of ponds and swamps which are the places where *L. aurea* spawn. The correlation between the presence of *Gambusia* and the absence of *L. aurea* at sites where the latter was once common suggests that one reason for the Bell frog's decline is the presence

of this fish. At Homebush Bay the only sites where *L. aurea* tadpoles occur are those that do not possess *Gambusia* (Greer pers. comm.).

Bell frogs have been observed at Jervis Bay National Park (Kristo; Merdith; Osborne pers. comm.). The author surveyed this Park's herpetofauna from March 1994 to February 1995. The Park was visited a total of twenty separate days, six of which involved night surveys which targetted potential frog breeding sites. Only one Bell frog was located. This specimen, a gravid female, was found on Bowen Island (Daly 1995). This island had been extensively cleared of native vegetation during the 1940's for agricultural and military purposes. Until a feral Rat eradication programme was initiated in 1994 the island had a large population of Black Rats (*Rattus rattus*) (Meek, pers comm.). The Bell frog was located on a fallen branch in a crevice that drained water from perched ephemeral swamps to the sea. The vegetation in the immediate area was wet heath, consisting primarily of sheoaks (*Casuarina distyla*) and heath Banksia (*Banksia ericifolia*).

No mosquito fish were observed in the Park so it is unlikely the general absence of these frogs is attributable to *Gambusia*. Mr P. Meek is currently surveying feral foxes in Jervis Bay National Park. He found a *L. aurea* in the stomach of a dissected fox.

The largest population of *L. aurea* tadpoles observed by the author was at Rosebery Sydney. This site is a drainage pond some 40 by 10 metres. The immediate area is covered by loose fill, of sand/sandstone, with large irregular sandstone rocks lining the southern edge of the pond. The only significant aquatic vegetation in the area is water couch (*Paspalum paspaloides*) and there are no mosquito fish. This site was the subject of a Fauna Impact Statement conducted by Dr H. Cogger (1993).

During the past three years there has been extensive and intensive fauna surveys conducted by the NSW State Forests. Surveys have been conducted at Dorrigo, Tallaganda/Badja, Tenterfield, Coffs Harbour, Glenn Innes, Wingham, Mount Royal and Kempsey-Wauchope. The majority of State Forests occur along the Great Dividing Range at altitudes ie from 400-1000 m Australian Height Datum. No *L. aurea* have been located during these surveys which indicates that Bell frogs are generally absent from montane areas. At present *L.aurea* has been observed in swamps of the coast and plains, wet heath and woodlands. No animals have been located in rainforest or wet sclerophyll forest (pers. obs.). The populations around Canberra occupied cumbungi swamps in areas of low topographic change (pers. obs.).

The sites utilised by *L.aurea* in the Illawarra for breeding, generally are swamps that possess non emergent aquatic plant species. Spawn has been observed amongst knotweed and water couch. Bell frogs probably also spawn amongst water primrose. The substrata at most sites is sand or a sandy loam which may be a result of the species habitat preference of coastal swamps. Adults shelter in cumbungi which is presumably preferred because the leaves have the structural capacity to hold an adult and are sufficiently broad to mask the overall form of this large frog.

A problem with assessing populations of anurans is the difficulty in finding and observing females. Male frogs call so their presence can often be detected, however female frogs do not call (except in distress). It is not known if all frog species are composed of males and females in the ratio of 1:1. In the current survey a total of 20 male frogs were observed around ponds C and D but observations of spawns and tadpoles indicate that only 4 females bred. Similarly at site A a total of 26 frogs were seen on a single night. Of these only 5 were female (van de Mortel pers. comm.). Further work is required to assess the sex ratio in this species.

There may be a difference in body colour between male and female Bell frogs. Female frogs generally lack dorsal brown blotches. Robinson (1993) states that the female kept by staff at the Australian Museum was almost entirely green. I have seen several female *L.aurea* that were green dorsally whereas the majority of males have various amounts of brown patches

dorsally. It is suggested that sexual dimorphism exists in this species and females generally lack dorsal brown blotches.

Observations of free range individuals at Nowra, Musselbrook and Wollongong indicate that this species basks while resting on aquatic vegetation (particularly cumbungi). They have been observed basking at 32°C (pers. obs.). Other basking frogs include *L.caerulea, L. fallax* and *L.latopalmata* (pers. obs.). Barker and Grigg (1977) state that members of the *L. aurea* complex are active by day and actively soak up the warmth of the sun and it is assumed from this account that *L. castanea, L. cyclohynchus, L. moori* and *L. raniformis* sunbake. Tyler (1992) states that *Cyclorana australis* sunbakes. Adults appear in September, are active during summer and go into hibernation during April. Juveniles disappear and probably go into hibernation during May. Although the majority of sites occupied by *L. aurea* occur close to sea level individuals have been located at 250 m AHD at Helensburgh NSW (during the summer of 1982 pers. obs.) and at 750 m AHD at Canberra (Osborne, pers. comm.).

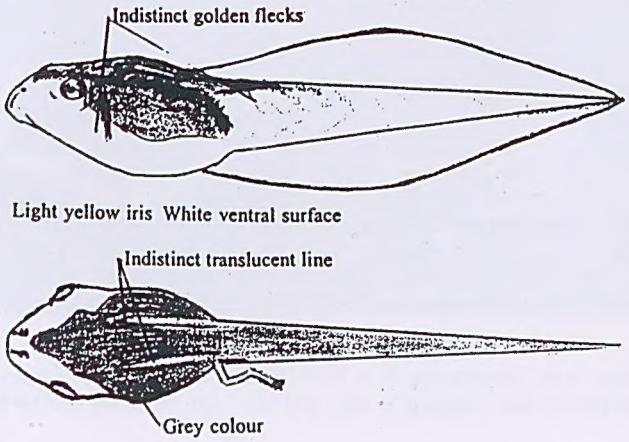
Green and Golden Bell frog's suggested high temperature preference would imply that it can colonise subtropical/tropical climes. This is demonstrated by feral populations existing in New Caledonia (Greer 1994) and several islands in the New Hebrides group (Tyler 1979). The reasons why *L. aurea* has not colonised areas north of Byron Bay is unclear. Recent surveys of the Frog and Tadpole Study Group suggest that northern population have fared worse than those occurring in Sydney and coastal areas south of Sydney.

Fletcher (1889) stated that this species breeds from about the middle of spring through the summer and observed numbers of individuals in the same pond for three successive years in late September. Males were darting at and seizing the females; but little or no spawn was deposited. He found amplecting pairs and or spawn in October and December. These observations and those from this study indicate that reproduction in *L. aurea* is seasonal. Activity appears to be highest in summer immediately after heavy downpours of rain.

The tadpoles of *L. aurea* are large and distinct. They can reach a maximum length of 80 mm (Daly in press) and are a brown/green color dorsally (Figure 2). The only other species of *Litoria* in NSW observed by the author that have tadpoles that are similar in size and colour to *L. aurea*

Figure 2.

Litoria aurea Length (s- v) 27mm (t - l) 75mm



is *L.peroni* and *L.tyleri*. These species can be distinguished from *L.aurea* because they possess a yellow/white midnasal patch.

Bell frog tadpoles generally have benthic habits. They do not display the characteristic behaviour of several other species of *Litoria* of congregating in the upper levels of the pond and positioning themselves by small rapid movements of the distal portion of their tails. Several *Litoria* spp (ie *L. peroni, L. verreauxi, L. tyleri, L. littlejohni*) characteristically maintain a near vertical position by the tail movements described above. In contrast *L.aurea* either lie on the bottom of the pond or hide in the thick aquatic vegetation that fringe the edge of the pond. When *L.aurea* tadpoles swim they make slow regular movements.

Harrison (1922) states that the minimum time for *L.aurea* tadpoles to complete metamorphosis is five months. However, they have metamorphosed within six weeks (van de Mortel, pers. comm.). Observations of free range tadpoles by the author indicate that transformation from tadpole to frog can take up to twelve months. This suggests that *L.aurea* must, to breed successfully, select ponds that are permanent or dry out only infrequently. This suggestion is in accordance with observations of the sites utilised by *L.aurea* for breeding.

The present status of *L.aurea* in NSW indicates that immediate strategies should be implemented to ensure the species continual survival. All populations warrant annual monitoring. Areas adjacent to extant populations should be developed so that new adult and breeding habitat is created. Land owners with farm dams located close to known Bell frog populations should be encouraged to drain these dams so that they are fish free. Relocation of tadpoles from sites which possess a large tadpole population to nearby sites that are fish free and possess suitable habitat should be trialled. This strategy is also suggested by Cogger (1993).

The high mobility of this species means that it crosses roads and is susceptible to mortality by moving vehicles (Figure 3). In urban areas populations face the prospect of local extinction via road kills. Developments, particularly urbanisation close to Bell frog breeding sites is not acceptable. Specific on site management of urban populations are outlined by Greer (1993).

Figure 3. Road killed *L.aurea*, Shoalhaven Heads

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I thank Dr A. Greer, Dr W. Osborne and Dr A. White for their critical review of the manuscript, Shoalhaven Starches for their metrological data and Ms T. van de Mortel and Mr M. Murphy

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FIELD OBSERVATIONS, CAPTIVE BREEDING AND GROWTH RATES OF THE LACE MONITOR, *VARANUS VARIUS*

Terry Boylan
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INTRODUCTION

The Lace Monitor or Tree Goanna, *Varanus varius* is a large varanid with a widespread distribution throughout eastern Australia. Although commonly kept in captivity, reproduction of the species in zoos has been sporadic (Horn and Visser, 1989). As with some other large varanids, *V.varius* is known to deposit its eggs in termitaria situated on the ground (Cogger, 1959; Worrell, 1963; McPhee, 1959) and in termitaria situated in tree branches (Longley, 1945; Fleay, 1953; Tasoulis, 1992). A *Varanus varius* in captivity at Taronga Zoo was induced to oviposit in a living termite mound introduced into its outside enclosure.

NESTING OBSERVATION IN THE WILD

At 1700 hours on the 13th January 1987 at Termeil on the south coast of NSW, a farmer Mr Joe Smith, observed in his paddock a "small tree goanna" (*V.varius*), with a third of its body, head first inside a tunnel it had excavated in a termite mound. The termite nest was approximately 25cm diameter x 15cm high.

After forty minutes examining the tunnel, the goanna left the termite mound where "some twenty eggs neatly stacked" were subsequently found in the exposed burrow. This same animal returned to the termite mound at 1000 hours the following day and reportedly made some attempt to seal the burrow. The termites had completely repaired the hole and sealed in the eggs one day later. Nineteen eggs were found to have been oviposited in a chamber situated some 15cm beneath the mound's ground level and some 20cm from the burrow opening at an angle of 45 degrees. Of 25 *V.various* nests examined by Carter (1992) in termite mound, the mean clutch size was about 8 eggs. It is therefore possible that this clutch of 19 eggs represented oviposition from more than one female. The eggs were removed and deposited at Taronga Zoo on the 28th January 1988. One egg was damaged during excavation of the nest and was discarded. Three eggs were represented by empty shells and contained a network of termite tunnels. It could not be ascertained if these shells were part of the freshly laid clutch or from a previous clutch. A brown encrustation secreted by the termites encased the intact eggs. It was later reported by the original observer that the same female monitor returned to her nest site in September of the same year and was seen scratching at the base of the mound. This would have corresponded to the emergent time of the hatchlings if left inside the termite mound.

Tree termitaria are also used for ovipositing. In 1988, nine newly dead juvenile *V.varius*, with no apparent signs of external injury, were brought to the Zoo after they were reportedly killed when a termite mound crashed some 10 metres to the ground. It was not ascertained if these hatchlings (remains of umbilicus were present) were inside the termite mound or resting on it. Their average weight was 12.8gms, average snout vent length was 10.6 centimetres and average tail length was 16.5 centimetres.

ARTIFICIAL INCUBATION

All of the 15 remaining eggs (average weight was 36gm, length 54mm and width 36mm) from the Termeil clutch were incubated in vermiculite at a temperature of 29° - 31°C. Two eggs spoiled and were opened on the 4th August 1987 to reveal dead embryos. One egg hatched on 31 July 1987 and six had their shells slit by keepers on 1st August and emerged unaided the following day. A further six eggs were opened on the 4th August and the live juveniles removed. All thirteen neonates survived and were successfully reared.

CAPTIVE BREEDING

A 1.3m (total length) female *V.varius*, which hatched at Taronga Zoo in 1987 from eggs removed from a termite mound at Termeil on the south coast of NSW, first deposited 5 eggs scattered in an outside enclosure at Taronga Zoo in 1990. These were partly devoured by either the female, or more likely by two other *V.varius* sharing the enclosure. No mating was observed and egg fertility was not determined.

A live termite mound "planted" in 1978 to stimulate and facilitate appropriate egg oviposition by this species, was not used for this first oviposition.

The mound, of the termite species *Nasutitermes exitiosus*, was approximately 15cm x 15cm wide when transplanted from Sydney bushland into the enclosure and by the time of the second egg laying in 1993 was approximately 40cm x 60cm wide. A 300 watt strip heater was suspended over the termitaria. From about 1990 onwards the female would spend most of her time either perched on or in close proximity to the mound. This contrasted with two male cagemates, who took up residence at the front and more sunny part of the exhibit.

During September and October 1990 the female was often observed scratching at the sides of the termitaria. In March 1992, a pair were observed mating. In September 1992 the female was suspected of being gravid due to her larger than normal girth and increasing activity (tongue flicking and desultory scratching) at the termite mound. Radiographs a few weeks later indicated otherwise and no trace of eggs was ever found.

On the 2nd September 1993, a hatchling was observed basking on a branch within the enclosure. On opening the mound a further four neonates were discovered with one egg in the process of hatching (Fig. 1). Two more eggs were encrusted in termite secretions (Fig. 2) but otherwise appeared viable. One of these was slit to reveal a fully formed embryo which died within 48 hours without emerging. The remaining egg was removed and successfully incubated in vermiculite, hatching on the 19th September 1993. All eggs and neonates within the mound were situated within a nest chamber which measured 8cm x 25cm wide and some 10cm above ground level. Prior to our opening the termitaria, the female displayed aggression towards both male *V.varius* and any person approaching the nest site.

At the time the first hatchling was observed outside the nest mound, the female had burrowed into the vicinity of the hatching eggs within the next chamber and would spend much of her time the following week partially in the burrow.

Table 1. Weights (in grams) and body measurements (in mm) of two groups of *Varanus varius* on hatching at Taronga Zoo.

WEIGHT	S/V LENGTH	VENT TAIL	WEIGHT	S/V LENGTH	VENT TAIL
*22.3	120	177	26.9	140	191
16.8	121	177	28.2	142	193
17.2	122	174	25.1	124	180
18.4	128	182	27.6	148	193
19.4	128	186	24.9	155	199
17.1	122	172	28.0	147	196
17.6	127	185	22.2	153	198
22.1	128	192			
21.5	126	185			
20.4	124	183			
18.4	119	174			
17.8	119	175			
16.0	126	174			

*Hatched unaided - By the 24th October 1988, this animal weighed 500g with S/V length 33cm and tail length 58cm.

Table 2. Average growth rates over a twelve month period for seven *Varanus varius* which hatched at Taronga Zoo in September 1983. Measurements in grams and millimetres.

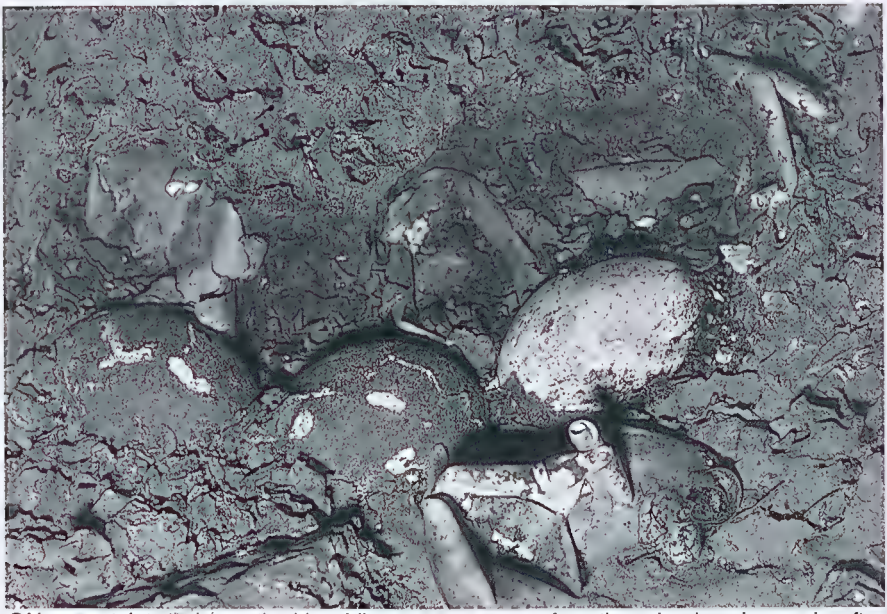
	WEIGHT	S/V LENGTH	VENT TAIL
Oct	28.3	146	214
Nov	39.9	149	246
Dec	59.9	159	278
Jan	69.1	171	299
Feb	78.5	184	324
Mar	88.3	190	337
Apr	101.3	199	353
May	120.4	205	372
Jun	136.2	223	395
Jul	162.4	229	407
Aug	202.1	248	434
Sep	234.5	260	468

DISCUSSION

Besides *V.varius,* at least seven other species of Varanids have been reported to utilise termitaria for egg oviposition: *V.rosenbergi* (Ehmann *et al* 1991), *V.gouldii* (Cogger, 1967), *V.griseus* (Sprackland, 1992), *V.bengalensis* (Smith, 1935), *V.exanthematicus* (Branch, 1988), *V.niloticus* (Cowles, 1959; Branch, 1988) and *V.salvator* (Daniel, 1983).

Figure 1. Three (of five) *V.varius* within the opened termite mound where they hatched. (Photo D. Spielmann).

Figure 2. Three viable *V.varius* eggs photographed in situ in an opened nest chamber. Two are encrusted with termite secretions. (Photo D. Spielmann).



Of less certainty is the method hatchlings use to emerge from these hardened mounds, after eggs have been sealed in by termites, though Cowles (1959) states that hatchling *Varanus niloticus* dig their way out.

The nest of the termite species *Nasutitermis exitiosis*, which constructs its mounds either on the ground or in eucalypt trees, is often used as an incubation chamber for eggs oviposited by *Varanus varius*. The original hypothesis proposed by Cogger (1967), was that female *V.varius* remain near the nest site and assist in freeing the emerging young. Carter (1992) argued that females perform their normal foraging activities and return to nest sites prior to, or at the time of hatching, in order to open the mound for hatchlings (which Carter believes are incapable of digging their way out).

The Taronga Zoo female *V.varius* had burrowed into her nest chamber inside the termite mound as the eggs were hatching, and it is assumed that the neonate first observed outside the mound was freed by the female.

The protective behaviour of the Zoo female towards her nest site was also observed in a captive female after oviposition by Horn (1991).

Horn and Visser (1989) report captive bred hatchlings having weights of 32-36g and 33-40.8g, whilst Bredl and Schwaner (1983) reported weights of 32-36g. Weavers (1988) recorded weights of 21.6 - 25.3g for wild hatchlings, so it would seem that the dead hatchlings deposited at the Zoo in 1988 were comparatively light (albeit with a corresponding comparatively smaller size) possibly through inanition and dehydration due to entombment within the mound.

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THE EFFECT OF AN INADEQUATE KEY: *RAMPHOTYPHLOPS BROOMI* (SQUAMATA: TYPHLOPIDAE) DOES NOT OCCUR IN NEW SOUTH WALES

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The use of dichotomous keys for the identification of animals is widely recommended (e.g. Mayr, 1969; Wiley, 1981). However, the identifications made through the use of such keys are only as good as the keys themselves. For simplicity, most keys available to the Australian herpetofauna (e.g. Cogger, 1992; Storr *et al*, 1986) generally use only single characters at each step. If the character chosen to differentiate at each step is not completely diagnostic, or is inadequately defined, errors in identification can result. Unfortunately, many users of keys seem not to use the descriptive accounts in identification guides to confirm the identification made.

One example of a persistent error in the literature, resulting from an inadequate key, is the recognition of *Ramphotyphlops broomi* in New South Wales. This species was originally described from a specimen from Muldiva in north Queensland (Boulenger, 1898). Waite (1918), in the key in his monograph of the Australian typhlopids, used a single terminal character state, the complete division of the nasal shield by the nasal cleft, to differentiate the species from *Ramphotyphlops wiedii* (Peters, 1867). Both species otherwise shared the combination of 20 midbody scales, nasal cleft contacting the second supralabial, and a rounded, blunt snout. Waite's key, including the terminal dichotomy separating *R.broomi* and *R.wiedii*, was subsequently used as a basis for other keys to the Australian typhlopids (Kinghorn, 1929; Cogger, 1992; Gow, 1976). Waite's accompanying descriptions and illustrations, however, clearly noted additional features differentiating the two species: the presence of a strongly striped pattern in *R.broomi*, absent in *R.wiedii*, and the limited dorsal extent of the nasal cleft in *R.broomi* with respect to *R.wiedii*. Neither character has previously been used in diagnostic keys.

Waite identified only five specimens of *R.broomi* in his revision, from Cairns, north Queensland, mallee district of Victoria, Norseman and Broome. Although he indicated that his revision included material from the Australian Museum, Macleay Museum, Museum of Victoria, Queensland Museum, South Australian Museum and Western Australian Museum, he did not specifically identify registration numbers, and it is difficult to determine the basis for his records. However, it is likely that Australian Museum R2034 (north Queensland), identified in the original register as examined by Waite, is one of the five specimens.

Although no complete revision of eastern Australian typhlopids has subsequently appeared, several authors have doubted or rejected Waite's records of *R.broomi* from outside Queensland. Storr (1981), who examined all available typhlopid material in the Western Australian Museum, did not record the species from Western Australia, and rejected the Norseman and Broome localities. Rawlinson (1966), although recognising Waite's record from Victoria, was unable to identify any specimens in the Museum of Victoria to verify the locality, and Robertson *et al.* (1989: 70) were similarly doubtful of the reliability of Waite's Victorian typhlopid records. Coventry & Robertson (1991) did not recognise the species as occurring in Victoria.

Although Cogger & Lindner (1974) reported two specimens of *R.broomi* (AM R30068-69) from Cobourg Peninsular in the Northern Territory, my examination of these specimens has shown them to be misidentified *R.tovelli*.

Even in Queensland, *R.broomi* remained little known. Ingram & Raven (1991) gave only a single locality in north Queensland, based on Queensland Museum records. Most recently, Ingram &

Covacevich (1993) tentatively applied the name *R.broomi* to a species restricted to a small area of north Queensland from the western edge of the Atherton Tableland to Cooktown.

Despite these doubts and restrictions, *R.broomi* has been mapped from a wide area of New South Wales by most recent authors (Cogger, 1992; Ehmann, 1992; Wilson & Knowles, 1988; Swan, 1990). Indeed, the latter two authors give specific localities in New South Wales. Wilson & Knowles (1988) figure an Australian Museum specimen (R40113) from Scone, and Swan (1990) maps seven localities in the state. Only Weigel (1990) did not record the species from New South Wales.

There are a number of New South Wales typhlopids in the Australian Museum identified as *R.broomi*. Many of these key to *R.broomi* in available keys due to the complete division of the nasal shield by the nasal cleft. However, in all other respects, including their plain dorsal coloration and the dorsal extent of the nasal cleft, they are identical with *R.wiedii*, and fall within the known distribution of that species. Comparison of these specimens with *R.broomi* from north Queensland also reveals a rather broader rostral in the southern specimens, as in *R.wiedii*. Consequently, I reidentify all records of *R.broomi* from New South Wales as *R.wiedii*. The degree of division of the nasal shield is variable in *R.wiedii*. In most specimens, the long nasal cleft narrowly fails to reach the margin of the rostral shield dorsomedially. However, in occasional specimens, the cleft extends to nearly or completely divide the nasal.

With the reidentification of these specimens, the striped *R.broomi* and the unpatterned *R.wiedii* (bright pink to pink-brown in life) are allopatrically distributed in eastern Australia. The northernmost limit of the distribution of *R.wiedii* is Homebush, near Mackay (AM R8031) (see also Ingram & Raven, 1991, for Queensland Museum records) and the southernmost records are from Koorawatha and the Kildara/Beckom region (Fig 1). In New South Wales, *R.wiedii* is primarily distributed along the western slopes, extending towards the coast through the Hunter Valley and in the extreme north-east, and is apparently absent from the high country around the New England tableland.

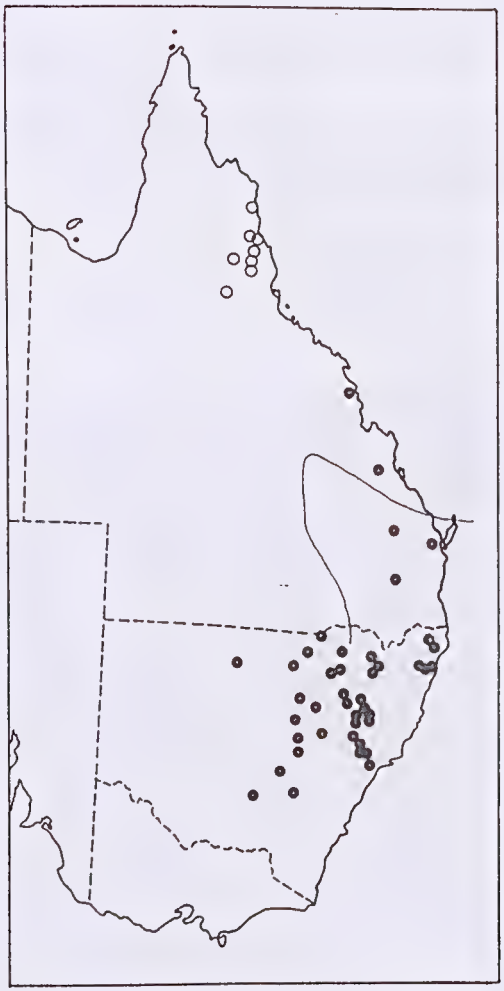
As *R.broomi* remains a poorly-known species (Ingram & Covacevich, 1993, report only 8 specimens and 6 localities), it is worth recording five additional Australian Museum specimens and three additional localities: R2034, north Queensland; R10314, Almaden, Qld; R17041, 40mi W. Cairns, Station property, Woothakota Shire, Qld; R12758, Mt Carbine, Qld; R128848, Mandalee, Innot Hot Springs, Qld.

Material examined (all specimens in Australian Museum, Sydney):

Ramphotyphlops wiedii: R1441, R40444, Dubbo; R1453a-l, Darling River floods, NSW; R1846, 11565, Moree, NSW; R2729, R6563, R6565, R6584, R107993, no locality; R3600, Koorawatha, NSW; R4122, Clarence R., NSW; R4544, R14920a-d, Boggabri, NSW; R5908, R6344, Eidsvold, Qld; R7091, Singleton, NSW; R7123, Copmanhurst, NSW; R7941, northwest NSW; R8031, Homebush, nr Mackay, Qld; R8427, Caswell, NSW; R9321, Mt Morgan, Qld; R9398, Blackmount, Qld; R11674, R13352, Quirindi, NSW; R11842, Bundarraga, Scone, NSW; R11885, Yeoval, Tumbie Stn, NSW; R12581, Bell, Qld; R12587, "The Rands", Bell, Qld; R12591, Chauvel Camp, Muswellbrook, NSW; R12761, Walgett, NSW; R12869, Terrace Ck gates, Doubtful Ck, NSW; R13101, Kildary and Beckom, NSW; R13454, Grafton, NSW; R13879a-d, Coonamble, NSW; R13998, R26143, R128505, Muswellbrook, NSW; R14929, R47517, Gunnedah, NSW; R14953, R15661, R86810, Warrumbungle Mtns, NSW; R15291, Bourke, NSW; R15328, Graman, NSW; R16757, Mungindi, NSW; R17714, Casino, NSW; R17863, Forbes, NSW; R17922-23, R19284, R27310-11, South Tamworth, NSW; R19388, Collarenebri, NSW; R20758, Dunedoo, NSW; R20999, Tamworth, NSW; R32740-41, R33038-40, R64011, 15mi W Gilgandra, NSW; R40104, R40107-12, R40115, Scott Memorial Hospital, Scone, NSW; R45484, Singleton area, NSW; R64291, Inverell district, NSW; R66805-06, Lawrence, NSW; R69722, Myallvale, NSW; R71171, Werris Creek, NSW;

R71311, Inverell, NSW; R84385, Cessnock, NSW; R89107, 7km S Jerry's Plains, NSW; R91886-87, Bowling Alley Point on Tamworth to Nundle Rd, NSW; R94784-85, Bellata tip, NSW; R95338, Copeton Dam, NSW; R95345, 3mi W Dungowan, NSW; R127379, Bartley St, Forbes, NSW; R128508, Muswellbrook, NSW; R129327, Manilla tip, NSW; R130480, South Grafton Common, NSW.

Fig. 1. Distribution of *Ramphotyphlops broomi* and *R.wiedii*. Open circles are records of *R.broomi*. Dots are Australian Museum records of *R.wiedii;* solid line marks approximate limit of *R.wiedii* distribution based on Queensland Museum records (Ingram & Raven, 1991).



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A CAPTURE/RECAPTURE STUDY OF THE ENDANGERED HYLID FROG *LITORIA AUREA*

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INTRODUCTION

The Green and Golden Bell Frog *Litoria aurea* occurs in eastern and south-eastern NSW and far eastern Victoria, in vegetation bordering streams, swamps and ponds (Cogger, 1992). Formerly a common and familiar species in NSW (Harrison, 1922-1925), it has suffered a drastic population decline there in recent years and is now listed as a threatened species (NSW NPWS revised Schedule 12, 1992). The cause or causes of this decline are uncertain. In contrast there is no evidence of a decline in Victoria (Gillespie, pers. comm.) and the species is not listed as threatened in that state (Department of Conservation and Natural Resources Threatened Fauna of Victoria, 1993).

The species was recorded during a recent survey of Seven Mile Beach National Park (34°47'S 150°46'E) on the NSW South Coast (Murphy, 1994). The adult population at this site was the subject of a capture/recapture study over the 1993/94 and 1994/95 warmer months, the results of which are reported here.

The vegetation and geography of the Seven Mile Beach area has been described previously (Murphy, 1994). The study site consisted of a vehicular track 230 metres long passing from *Eucalyptus pilularis/E.botryoides* open forest to *E.robusta* wet woodland, near the edge of Coomonderry Swamp in the west of the Park (Figure 1).

Figure 1. Study site at Seven Mile Beach National Park.

METHODS

The study site was visited on twenty nights between December 1993 and March 1994 (Year 1), and on twenty nights between December 1994 and March 1995 (Year 2). On each visit ten to twenty minutes were spent looking along the track for frogs. Each one found was photographed *in situ*, and the location noted. Comparison of the dorsal colour patterns using these photographs enabled the reidentification of individuals seen on multiple occasions.

RESULTS

Litoria aurea were seen at the study site between January 1994 and March 1994 in Year 1, and between December 1994 and February 1995 in Year 2. Eleven individuals were identified in Year 1, and six individuals in Year 2. Four frogs were recaptured within Year 1, of which one was caught again in Year 2, and another two were recaptured within Year 2. Details of these six frogs' captures and recaptures are shown in Table 1. The greatest movement recorded in one year was 90 metres in 19 days, the shortest movement 5 metres in twelve days. The frog caught in both years moved 65 metres in 7 days in Year 1, but had returned to its original location in Year 2.

Table 1: Capture and Recapture Data

Frog No.	1st date seen	2nd date seen	3rd date seen	Days elapsed	Distance moved (m)
1	02/01/94	17/01/94		15	30
2	17/01/94	05/02/94		19	90
3	05/02/94	12/02/94		7	65
		12/02/94	15/02/95	368	65
4	02/03/94	03/03/94		1	5
5	10/02/95	14/02/95		4	25
6	10/02/95	22/02/95		12	5

DISCUSSION

The capture/recapture technique gives only a minimum estimate of real movements. It assumes a straight line is followed from one sampling point to the next, and is biased against large scale movements where animals leave the study area and escape recapture. Nevertheless, it can provide some basic information on movement and behaviour. In the case of endangered species, any small addition to our knowledge may be of value in the conservation effort.

Records of home range size and site-fidelity for *Litoria aurea* have not previously been documented. This study showed that adult *Litoria aurea* can remain resident at a site within one season and from one year to the next, or range across a distance of at least ninety metres. Six of the observed sample of sixteen frogs in the study area showed some degree of fidelity to the site. No conclusions can be drawn on the behaviour of the other ten, as it is not known whether they had moved away from the site, were still resident but not active at the specific times the site was visited, or had died.

The population in the study area apparently did not breed during 1993/94 or 1994/95. No calling males were heard in a total of forty visits, although the site was located within thirty metres of the extensive reedland of Coomonderry Swamp. It is possible that this population is dependent for breeding on timely flooding of the *E.robusta* wet woodland bordering the swamp, creating breeding sites free of *Gambusia affinis*. Breeding was recorded two kilometres south in February 1994, in *Gambusia*-free farm dams (Murphy, 1994).

The number of individuals seen in the study area decreased by almost half from the first to the second year. This may have reflected a real decline in the Park's population (associated with failure to breed or part of the species' general decline?), but is more likely to have been an

artefact of differences in weather conditions between the two years. *Litoria aurea* were active at the study site on ten nights in Year 1 but only seven nights in Year 2.

This study has provided evidence of site-fidelity and measurements of minimum home range size for *Litoria aurea*. Further research examining maximum movements is required before conclusions can be drawn regarding the minimum area needed to support a population.

ACKNOWLEDGEMENTS

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ANNOTATED CHECKLIST OF THE REPTILES OF WAGGA WAGGA AND DISTRICT, NSW

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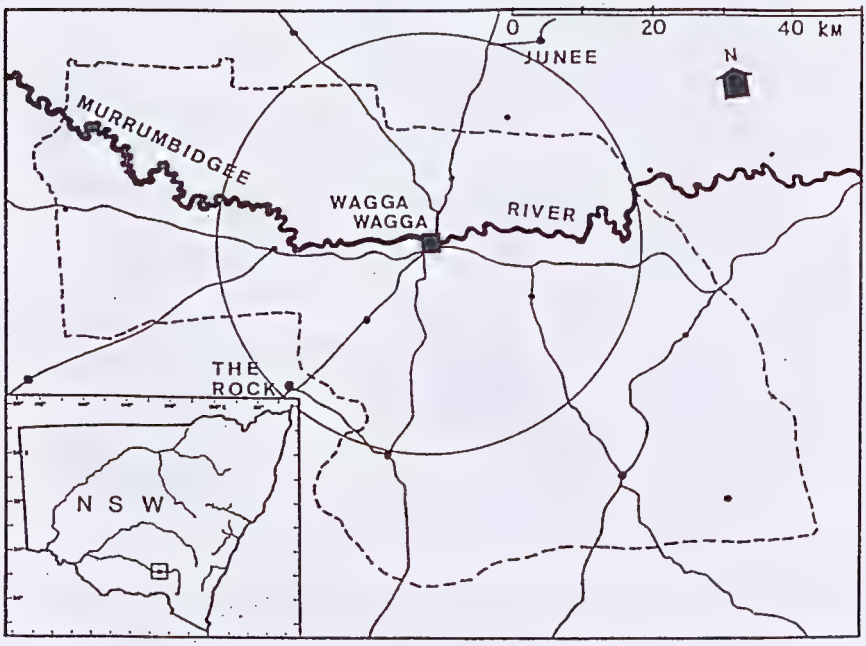
ABSTRACT

750 reptile specimens comprising 38 species, representing 30 genera and 7 families were examined from the Wagga Wagga area. A further 9 species might be expected to occur in the area or nearby regions. Two species not previously recorded from the area, *Gehyra variegata* and *Lerista muelleri*, are south-east range extensions for these species. Significant habitat alteration in the area has probably resulted in reduction in reptile numbers and species densities. Fractionation of habitat has resulted in the isolation of many populations.

INTRODUCTION

The city of Wagga (Fig. 1) population about 50,000 and area of about 4880 km^2 lies on the Murrumbidgee River in the Riverina district of NSW at approximately 35°S, 147°W, and at an altitude of 220m. Most observations were made in a study area of radius 30 km based on the city centre. The urban part of the city is now surrounded by gently rolling, grass covered hills and flood plains with scattered remnants of open to moderately dense dry sclerophyll forests. Scattered rocky outcrops are another feature of the region. Large areas are devoted to wheat, oats and barley crops. Farming activities also include extensive sheep and cattle grazing so that very little if any unaltered habitat exists in the area. Occasional mouse plagues occur in the area and there are numerous feral cats and foxes.

Figure 1. Study area at Wagga Wagga, NSW.



The climate for the area is temperate, continental and sub-mesic. The average annual rainfall is 565mm but very variable (range 233mm - 987mm) with frequent but irregular droughts. The mean daily maximum temperature for January, the hottest month, is 31.1°C and for July, the coldest month, 12.5°C while the mean daily minimum temperature for January is 16.1°C and for July 2.4°C (Australian Bureau of Meteorology records over 72 years).

Geologically the area comprises a moderately complex arrangement of undifferentiated Paleozoic, Silurian and Ordovician rock formations. The soil types in the area include alluvial gravels, sands and clays on the flood plain with clayey to sandy soils based on decomposing granite in surrounding areas. Numerous small to large areas of granite or sandstone rocky outcrops also occur.

The Wagga Wagga area may have been rather neglected by herpetologists as demonstrated by the fact that out of over 3000 illustrations of Australian herpetofaunal species in recent literature (Cogger, 1975, 1986 and 1992; Gow and Swanson, 1980; Jenkins and Bartell, 1985; Hoser, 1989; Wilson and Knowles, 1989) only one specimen was listed as having come from Wagga Wagga.

This survey was carried out in order to increase understanding of the natural history of the area, the biology of the reptiles found and to provide a basis for future work in the area.

MATERIALS AND METHODS

Most of the data were collected on numerous field trips over a period of ten years between 1976 and 1986 covering various habitat types in and around Wagga Wagga as well as further afield. Observations were made throughout the year in various weather conditions. Many thousands of rocks, logs etc. were turned and other sites such as decorticating bark and exfoliating rocks etc. were also examined. Relatively few nocturnal observations and only general aquatic observations were made. Several collections in local High School science laboratories and local museums were also examined. The vast majority of specimens were captured by the author by hand, some were obtained as road kills, a few were brought in by interested members of the public, a few were caught by family cats and a few were caught in traps.

Specimens were identified by the author using the dichotomous keys in Cogger, 1979. An 'expected species' is defined as one having a distribution map covering the city of Wagga Wagga as shown in Cogger, 1979. It should be noted however that these distributions cover large areas where the species has not yet been found. It should also be noted that some species such as the Mountain Heath Dragon (*Tympanocryptis diemensis*) and the Southern Forest Cool-skink (*Niveoscincus coventryi*) are essentially high altitude taxa and would not realistically be expected at Wagga Wagga. Sample specimens of most species found have been lodged with the Australian Museum, Sydney.

RESULTS

The total number of specimens examined and identified was well over 1000. However there were only about 750 specimens from the Wagga Wagga area for which measurements and other details were recorded. A total of 38 species from 30 genera and seven families were found, this compares with about 55 'expected species' from 34 genera and seven families.

The nomenclature in the list following has been updated using Cogger, 1992 and common names follow Ehmann, 1992. General comments follow each family list. The number in parentheses following each species name indicates the number of positively identified and measured specimens which for common species represents only a fraction of the total number identified.

Order TESTUDINES
Family CHELIDAE

Chelodina expansa (Broad-shelled Snake-necked Turtle) (2)
Chelodina longicollis (Eastern Snake-necked Turtle) (18)
Emydura macquarii (Murray Short-necked Turtle) (1)

The latter two species are very common in the lagoons and dams near the flood plain with sightings of several dozen simultaneously on several occasions. *C.longicollis* has been seen up to 15 km from the river in mid-summer at air temperatures of about 38°C. The earliest spring sighting was August 26 and the latest autumn sighting was April 20. The very small number of hatchlings and juveniles seen near the city and also the obvious reduction in density of adults during the period of observation may indicate a low recruitment rate and possibly natural as well as unnatural emigration from this area. The status of *Chelodina expansa* in the area is unknown. No other species were expected in the study area.

Order SQUAMATA
Suborder SAURIA
Family GEKKONIDAE

Diplodactylus intermedius (Southern Spiny-tailed Gecko) (24)
Diplodactylus vittatus (Eastern Stone Gecko) (11)
Gehyra variegata (Variegated Dtella) (35)
Phyllodactylus marmoratus (Marbled Southern Gecko) (80)
Underwoodisaurus milii (Thick-tailed Gecko) (19)

With the exception of *P.marmoratus* none of the geckos could be described as common except in restricted areas. *P.marmoratus* was invariably found on or near large to very large *Eucalyptus* trees with decorticating bark. The other four gecko species were usually found in or near rocky areas although *D.intermedius* was occasionally found in leaf litter or low shrubbery, some specimens appeared to key out as *D.williamsi* (Eastern Spiny-tailed Gecko) (using Cogger, 1979) having more or less regular rows of enlarged dorsal and caudal tubercles. These were almost certainly slight variants of *D.intermedius* as other characteristics matched this latter species. *G.variegata* was not expected in the study area but is quite commonly found in rocky areas around Wagga. No other geckos were expected in the area.

Family PYGOPODIDAE

Delma inornata (Patternless Delma) (43)
Lialis burtonis (Burton's Snake-lizard) (2)
Pygopus lepidipodus (Southern Scaly-foot) (1)

D.inornata has been found singly or in aggregations up to six of various sizes. It occupies a variety of habitats including grasslands, open forests, rocky outcrops and farmlands. It is often active during the day in sheltered sites. One gravid specimen laid two large soft shelled eggs in different locations in a vivarium in December (unfortunately they failed to hatch). Several unconfirmed reports were obtained of additional specimens of *L.burtonis* and *P.lepidopodus* from the Wagga area but both species are no doubt sparsely distributed and probably only occur in local areas of suitable habitat. *Aprasia parapulchella* (Granite Worm-lizard) was expected and has been found around Canberra, West Wyalong, Cootamundra, and at Tarcutta (45 km SE) but has not been found in the study area nor in apparently suitable habitats in the intervening regions along the Murrumbidgee or Tarcutta Creek valleys. Although fossorial in behaviour this species is probably quite uncommon and deserves further study. Neither *Delma impar* (Many-lined Delma) nor *Pygopus nigriceps* (Western Scaly-foot) were found in the study area.

Family AGAMIDAE

Pogona barbata (Eastern Bearded Dragon) (9)
Physignathus lesueurii (Eastern Water Dragon) (1)

P.barbata is common in rocky areas, open woodlands and farmlands. *P.lesueurii* is uncommon in the study area but common in the higher altitude wooded and rocky creeks and rivers east of Wagga. Other expected species, *Amphibolurus muricatus* (Jacky Lizard) and *Tympanocryptis diemensis* (Mountain Heath Dragon) were not found within about 100 km east of Wagga. *Amphibolurus nobbi* (Nobbi Lashtail) was not found within about 60 km NW of Wagga and no specimens of *Tympanocryptis lineata* (Lined Earless Dragon) were found at all, Jenkins and Bartell (1980), indicate that this is a rare species in the SE Highlands.

Family VARANIDAE

Varanus gouldii (Sand Monitor) (2)
Varanus varius (Lace Monitor)

V.varius is common in wooded and rocky areas. They are often found as road kills or having been killed illegally by shooters. The largest specimen found was almost 2m long and had the tip of its tail missing. Two adult specimens were found in the winter, hibernating underground in long rabbit burrows one with a small breathing hole (?) about 20mm in diameter and 100mm deep immediately above the snout of the lizard. On one occasion a nest of about 15 eggs almost ready to hatch were found in an arboreal termites nest in late winter. No other varanid was expected from the area. In more recent times *V.rosenbergi* has been found in SE Australia but it is doubtful whether any were found in the study area.

Family SCINCIDAE

Carlia tetradactyla (Southern Rainbow Skink) (6)
Cryptoblepharus carnabyi (Spiny-palmed Shinning Skink) (35)
Ctenotus robustus (Robust Ctenotus) (42)
Ctenotus taeniolatus (Copper-tailed Ctenotus) (9)
Egernia cunninghami (Cunningham's Spiny-tailed Skink) (6)
Egernia striolata (Tree-crevice Skink) (44)
Hemiergis decresiensis (Three-toed Earless Skink) (94)
Leiolopisma platynotum (Red-throated Cool-skink) (5)
Lerista bougainvillii (South-eastern Slider) (16)
Lerista muelleri (Wood Mulch-slider) (34)
Menetia greyii (Common Dwarf Skink) (5)
Morethia boulengeri (South-eastern Morethia Skink) (119)
Tiliqua scincoides (Eastern Bluetongue) (25)
Trachydosaurus rugosus (Shingleback Lizard) (2)

Morethia boulengeri is extremely abundant and appears to have displaced other small litter skinks such as *Lampropholis guichenoti, Niveoscincus coventryi* and *L.delicata* found in the moister areas of the Southern Highlands. The usually arboreal *Cryptoblepharus carnabyi* is also very common in the area being found close to the central business district living on power poles and buildings with suitable crevices; it is also found in rocky areas, particularly on large rocks with lichen and suitable crevices. *Egernia cunninghami* are uncommon but some very large, almost unpatterned specimens were found in isolated rocky outcrops. *Egernia striolata* is very common in rocky areas and is only rarely found in association with trees even when these are present. *Hemiergis decresiensis* is common in some of the moister gullies under logs and rocks etc. *Lerista muelleri* was not expected in the study area but is quite commonly found under rocks and in relatively very dry soil. *Tiliqua scincoides* is uncommon in the study area, they were occasionally found active at night in very hot weather. The Wagga Wagga area seems to be the western limit of the highly melanic form of Trachydosaurus rugosus found in the Southern Highlands region.
Expected species not found in the study area include *Cryptoblepharus virgatus* (Cream-striped Shinning Skink), *Egernia saxatilis* (Black Crevice Skink), *Egernia whitii* (White's Rock Skink),

Lampropholis guichenoti (Pale-flecked Garden Sunskink), were not found closer than 60 km to the east. *Niveoscincus coventryi* (Southern Forest Cool-skink), *Eulamprus tympanum* (Cool-temperate Water-skink), (not found west of Mount Kosciusko area) and *Tiliqua nigrolutea* (blotched Bluetongue) (northern form) (not found west of Wee Jasper area). *Ctenotus uber* was not expected in the area although it was found both to the east and west of Wagga Wagga.

Suborder SERPENTES

Family TYPHLOPIDAE

Ramphotyphlops bituberculatus (Prong-snouted Blind Snake) (11)
Ramphotyphlops nigrescens (Blackish Blind Snake) (1)
Ramphotyphlops proximus (Proximus Blind Snake) (8)

In view of the fossorial behaviour of the family it is probable that the above species are more common than the numbers might indicate. No specimens of the only other typhlopid expected from the area, *Ramphotyphlops australis* (Southern Blind Snake) were found during the study.

Family BOIDAE

Morelia spilota variegata (Carpet Python) (11)

This is the only boid expected in the study area and is common in certain areas of open woodland with large rocky outcrops although because of their behaviour patterns they are not often seen. The largest specimen measured was nearly 4m in length.

Family ELAPIDAE

Furina diadema (Red-naped Snake) (1)
Pseudechis porphyriacus (Red-bellied Black Snake) (10)
Pseudonaja textilis (Eastern Brown Snake) (80)
Rhinoplocephalus dwyeri (Variable Black-backed Snake) (18)
Vermicella annulata (Eastern Bandy-bandy) (6)

Unconfirmed sightings of *F.diadema* were also reported but the species appears to be uncommon in the area. *P.porphyriacus* is common especially near waterways inhabited by frogs. *P.textilis* is also very common in the area and occurs in parkland and residential areas quite close to the city centre but is rarely seen by the public here, probably because it is very wary and very fast moving. Frequently the first indication to a resident of the species presence was demonstrated when a pet died suddenly of snakebite or one or more hatchling brown snakes appeared in or near the house. The first season juveniles are quite variable in colouration with few or many distinct black bands, vague bands or no bands across the body; all juvenile specimens had a distinct cream, yellow or bright orange collar between the broad black bands across the head and the nape. Almost all these colour patterns disappear by the middle of the second season or before. This species usually has some undivided anterior subcaudals (Annable, 1985) a characteristic found in Pseudechis and often used to distinguish it from *Pseudonaja*.

Expected elapid species included *Acanthophis antarcticus* (Southern Death Adder) but there was no evidence of its presence except a report of a single specimen seen many years ago. *Austrelaps superbus* (Copperhead), according to several landholders, is definitely present but uncommon; I found no specimens dead or alive in the wild or in local museums or preserved collections, it was found to the east near Batlow. *Rhinoplocephalus nigrescens* (Small-eyed Snake) was also expected but not found in the Wagga Wagga area, *Demansia psammophis* (Yellow-faced Whipsnake) may well be present in small numbers but was not found (it has however been found in adjacent areas). *Drysdalia coronoides* (White-lipped Snake) was not found or reported at all. *Notechis scutatus* (Eastern Tiger Snake) has been reported in the area although several landholders say numbers have declined in recent years or that it has disappeared entirely especially in irrigated districts. This may be linked to reduction in frog numbers as well as to other changes in habitat. Another reported but unconfirmed snake species was *Pseudechis australis* (King Brown Snake). A single specimen of *Denisonia devisi*

(De Vis' Banded Snake) was found near Leeton (120 km NW) and *Suta suta* (Curl Snake) near Narrandera (100 km NW) but neither was found in the study area.

CONCLUSIONS AND COMMENTS

High school and local museum collection specimens were very useful in confirming the presence of those species and also in providing information on variations in colour, morphology etc. The fact that most such specimens had very little good collection data meant that their value was very limited and that conclusions based on these collections could not be relied on with certainty.

Only two unexpected species (*Gehyra variegata* and *Lerista muelleri*) were found and they were not exceptionally far from known distributions as given by Cogger, 1979. Most of the species expected but not found are probably not present because of unsuitable habitat although a few may be present in low densities or in parts of the study area not examined. This particularly applies to the more cryptic, fossorial or nocturnal species. However, in view of the large number of hours expended searching in a wide variety of habitats, the number of specimens found probably gives some indication of relative abundance of the species except in the cases of nocturnal or aquatic species or very abundant species where only a limited proportion were actually examined in detail.

In view of the considerable disturbance to habitat in the area, it is suspected that the reptile numbers and species densities in the study area have been reduced and that land management practices have tended to fractionate populations and erect barriers to gene flow. However, some species are no doubt benefiting from the increased cover generated by rubbish tips, man-made debris, embankments etc. and also from the supply of water from dams and irrigation systems. It is gratifying to note that all except three of the expected species not found at Wagga Wagga were found elsewhere in the wider region of south-eastern New South Wales (the species being *Pygopus nigriceps, Tympanocryptis lineata* and *Ramphotyphlops australis*) indicating that maybe the damage being done to habitat is not critical at least as far as most species are concerned and that they are surviving despite the changes.

ACKNOWLEDGEMENTS

To the numerous schools and landholders in the area who allowed me to search their collections and/or properties.

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RAPID RECOVERY OF REPRODUCTIVE CONDITION IN A FEMALE *LITORIA INFRAFRENATA* (ANURA: HYLIDAE)

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ABSTRACT

Litoria infrafrenata is capable of a rapid return to reproductive condition. A captive female deposited two clutches within 26 days, each clutch being approximately 1000 eggs. Each time the female expended most of the visible mature eggs held in the body cavity, appearing thin after deposition.

INTRODUCTION

In late November 1994, I obtained a pair of White-lipped Tree frogs, *Litoria infrafrenata* which had been transported to Sydney in two separate consignments of fruit from far north Queensland (actual location unknown). The snout-vent length (SVL) of the female was 90mm and the male 85mm. The male's nuptial pads were pale brown and slightly raised.

Materials and Methods

The frogs were placed in a terrarium 90cm long that contained live broad leaved plants, logs and rocks and approximately 70mm of water (depth across tank floor). A small water pump drives a rain system and this operates once or twice a week. The terrarium also contained two other green tree frog species, *Litoria chloris* and *Litoria caerulea*. The terrarium is located in a room that, during summer has a temperature range of 28°C to 32°C with a mean of 30°C. The frogs were fed once a week on newborn mice and crickets.

OBSERVATIONS

The male began to call on the first evening after being placed in the terrarium. This calling continued every night up to the time of writing (January 1995) but stopped shortly after. Calling begins at approximately 1800 hrs and will continue for approximately 12 hours. The male could be heard calling solidly at any time during the night, only occasionally stopping for a short time (usually less than 60 seconds).

On the evening of December 1st 1994, the male stopped calling at approximately 2200hrs. On checking to see why the calling had stopped, the pair were discovered in axillary amplexus. No further calling was heard that night. The pair remained in amplexus overnight and into the next morning.

On the morning of December 2nd 1994, the male was heard giving a short call. Banks and Leyden (1990) state that the male gives a short call after releasing the female. The terrarium was checked and found to contain many separate clumps of eggs, some with the vegetal pole (white side) uppermost and some with the animal pole (black side) uppermost. Many of the clumps were a dumbbell shape as described by Banks and Leyden (1990), but not all.

Within ten minutes all eggs had rotated so that the animal pole was uppermost, indicating that successful fertilisation had taken place, and the separate clumps had swollen to form a solid sheet of eggs floating on the surface. The egg sheet was rarely more than one egg in depth below the surface. An estimation of clutch size was made by using a grid system (eggs per 2 square cm x surface area covered).

On the 21st December 1994, 19 days after the first clutch was laid, the male was transferred to a small holding container. The female and male were separated for 6 days between the 21st

and 27th December. Neither frog was observed during this time. No food was offered to either frog during this period.

The female was examined on the 27th December and appeared to be heavy, particularly in the abdominal region and it was apparent that she had developed a large quantity of mature eggs.

The male was placed in the terrarium with the female at 2055 hrs. He began to call at approximately 2130hrs but stopped at approximately 2200hrs. On checking, the pair were again discovered in amplex, just over one hour since returning the male to the female after a 6 day separation.

On the following morning, a sheet of eggs was present and had been laid some time between 2200hrs and 0800hrs. This egg mass had a similar surface area coverage as the first clutch, having already swollen to become one sheet of eggs. The same method was used to estimate numbers as with the first clutch.

DISCUSSION

Banks and Leyden (1990) record egg laying for this species at intervals of almost exactly one calendar month, but this was with a group of frogs and no details on individual females was given. They also noted clutch sizes with visual estimates ranging from 300 to 800 eggs but closer examination of clutches showed actual egg numbers to be between 1500-2900.

Seven days prior to the second clutch the female did not appear to have gained a noticeable amount of weight. Most of the development of mature eggs in the abdomen appears to have taken place in these seven days. During this time the male was housed separately and he did not call.

Approximately 2 or 3 days after the first clutch the water level of the terrarium was lowered to about 35mm. The rain machine was removed from the tank. No food was offered to either frog in the seven days before the second clutch. The male's nuptial pads grew larger and darker after the first clutch, and then faded to pale fleshy marks once calling ceased.

The male lost muscle condition during the calling period and appeared thin with bones on his back and legs becoming prominent. The female did not appear to lose this condition. These frogs, when given adequate conditions, appear to do well in captivity. It also appears that they are quite tolerant of disturbance as evidenced by the transfer of the male to a small holding container, not only for the seven days prior to the second clutch, but also on a regular nightly basis, and his continued vigour when returned to the terrarium.

ACKNOWLEDGEMENTS

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CAPTIVE REPRODUCTION IN *PSEUDECHIS AUSTRALIS* (SERPENTES: ELAPIDAE) FROM WESTERN AUSTRALIA, AND NOTES ON OTHER *PSEUDECHIS* SPECIES

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Fitzgerald & Pollitt (1981) and Fyfe (1991) determined that oviparity is the mode of reproduction in *Pseudechis australis* from eastern and central Australia respectively. Here I record oviparity in this species from Whim Creek, north Western Australia (20°51'S 117°50'E) suggesting oviparity is consistent in populations from the extreme west to the east of Australia. In WA the known southern extremity of this species' distribution is Yornaning (32°45'S 117°09'E) (Smith, 1982). In this area the dorsal colour of individuals is dark brownish-black to black. John Dell of the WA Museum has suggested to me that the "black mulga" of the Yornaning area may in fact be an undescribed taxon.

As well as presenting my data on *P.australis* I combine it with previously published records and include a comparison with the other oviparous members of *Pseudechis, butleri, colletti* and *guttatus* (Table 1). To date I have been unsuccessful in my endeavours to hatch eggs from *P.butleri*. This may be related to the fact that the female was X-rayed in 1987. Nevertheless I have combined my previously unpublished data on this species with that of Fitzgerald & Mengden (1987).

THIS RECORD

A 115cm female *P.australis* was placed in a 100 x 75cm all-glass terrarium with an 85cm male on the morning of 22 September 1993. Jerking and tail-thrashing in the male and tail thrashing only in the female was displayed immediately, culminating in the female attempting to elude the pursuing male. The snakes were not observed again until 3.30pm, at which time they were in copula and this continued for a further 40 minutes, during which the female displayed considerable swelling for the circumference of the body immediately forward of the cloaca. As soon as the pair parted the female was returned to her regular 90 x 40cm all-glass terrarium.

Although I have recorded multiple matings in pythons I have yet to observe this in the elapids that I have bred. After successful copulation the female will not respond to the male's attempts to mate again however Charles (1983) records multiple mating in *P.colletti*.

Six days later I noticed pronounced lateral swellings in the female, one on each side and about 1cm wide extending from the cloaca forward for about 3cm. This swelling was unlike that observed during copulation in that it was restricted to the sides of the body. It subsided gradually over the next three days.

On the 3 November, 42 days after mating 16 eggs, 14 of which were good and 2 partly developed small yellowish spheres, were deposited. The mean length, width (mm) and weight (g) of the 14 good eggs was 40.14, 22.93 and 13.05 respectively. The combined mass of all 16 eggs was 193.63g and the female's weight immediately post parturition was 473.5g (Relative Clutch Mass = 0.409).

The eggs were incubated in a 3 to 1 vermiculite to water mixture at 30°C.

All but two hatched between 27-30 January 1994 which gave an incubation time of 85-88 days. No total lengths were recorded however the mean SVL of 11 neonates was 244.2mm (231-260) and weight was 9.4g (7.93-10.42). Postnatal sloughs occurred 17-22 days post hatching.

Figure 1 illustrates what I thought was a two-headed snake. To avoid any problems a two-headed individual might have in hatching I made an incision in the egg shell between them.

Table 1. Comparative Egg and Neonate Data in *Pseudechis spp*

DAYS BETWEEN MATING AND EGGLAYING:	
australis	45-63 days [1]; 42[2]
colletti	72-79 days from last mating[3]
FECUNDITY:	
australis	9-16 (mean 12.75, N8)[1,2,6]
butleri	4-12 (mean 8, N6)[2,4]
colletti	7-12 (mean 8.66, N3)[3]
guttatus	7-13 (mean 9.5, N4)[5]
EGG SIZE	
australis	33 -46 (40mm) x 21 - 25 (23) x 11.6 - 14.4 (13g) N1[2] clutch
butleri	41 -75 (58.6mm) x 21 - 25 (24) x 10.7 - 29.7 (18g) N5 clutches for length/width & N2[2] for weight
colletti	W 28 56 (36.6g)[3]
guttatus	No data
INCUBATION PERIOD:	
australis	70-72 days (22-32°C)[1]; 65-68 (30-32°C)[6]; 85-88 (30°C)[2]
butleri	65-80 days at 30°C[4]
colletti	82-91 days at 27°C[3]
guttatus	77 days at room temperature and 84 at 24°C[5]
NEONATE SIZE:	
australis	SVL 198-260 (222mm), W 5.3-10.6 (8.7g)[1]; 285-330 (312), W 13g[6]; 231-260 (244), W 7.9-10.4 (9.4g)[2]
butleri	SVL 310-350 (324mm)[3]
colletti	SVL 250-290 (276mm)[4]
guttatus	SVL (2 weeks post hatching) 226-242 (234mm)[5]

SOURCE OF DATA

[1] Fitzgerald & Pollitt (1981)

[2] Bush, B. Present study.

[3] Charles (1983)

[4] Fitzgerald & Mengden (1987)

[5] Charles *et al* (1979)

[6] Fyfe (1991)

Imagine my disappointment when two neonates finally crawled out! This pair had respective SVL's and weights of 197, 192mm and 4.8, 4.18g or approximately half that of the mean weight of the other 11 neonates.

The smallest and largest juveniles respectively at 12 months of age have SVL's of 290 and 615mm (at hatching 192 and 260) and weight 34.14 and 119.55g (4.18 and 10.42).

Figure 1. Two neonatal *Pseudechis australis* emerging from a single egg.

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CAPTIVE REPRODUCTION OF BOYD'S RAINFOREST DRAGON (*HYPSILURUS BOYDII*) AT WILDWORLD, CAIRNS

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INTRODUCTION

Boyd's Rainforest Dragon (*Hypsilurus boydii*) is an arboreal agamid occurring in the Wet Tropics of North Queensland (Nix & Switzer, 1991), a region of tropical rainforest that extends from Cooktown to Townsville.

Although apparently relatively common, this species is seldom seen due to its cryptic habits. It inhabits rainforest and associated ecotone environments to elevations up to 1100m (Nix & Switzer, 1991). Anecdotal reports of the diet of *H.boydii* suggest that it is primarily an invertebrate feeder, preying on insects, slugs and snails, as well as rainforest fruits (Nix & Switzer, 1991). However, vertebrate prey such as birds have also been documented (Zwinenberg, 1974). In captivity, Leaf-tailed gecko eggs (*Phyllurus sp.*) and goldfish (Barnett, 1981), as well as new born mice and mince meat (pers. obs.) are also consumed.

Only two accounts of captive maintenance are cited for this species (Cermak, 1986; Barnett, 1981). Here we report captive maintenance and breeding of a pair of *H.boydii* at Wildworld Wildlife Park, Cairns.

DESCRIPTION OF BREEDING ENCLOSURE

The breeding pair of Boyd's Rainforest Dragons at Wildworld are housed in a rainforest aviary measuring 7.4 x 7.4 x 2.3m. It is covered with 1cm square wire mesh. There is a 7.4 x 2.0 x 2.3m sheltered area at the rear of the aviary.

Areas of the aviary have been landscaped to provide a natural rainforest setting. The dragons tend to choose a favoured site, normally a vertical trunk, which at times may be occupied for up to a week. Apart from the female when she is gravid the animals were never witnessed purposely basking, always preferring to seek shelter offered by the vegetation. The lizards are generally only observed foraging in the open or climbing the wire on overcast, wet or humid days. During warmer weather the lizards secluded themselves in clumps of vegetation presumably to try to avoid exposure to sun and heat. On especially hot days, overhead sprinklers were turned on to reduce the risk of dehydration for both birds and dragons.

The aviary contains ten species of rainforest birds, none of which have been observed to display any antagonistic behaviour towards the dragons. However, a colony of Buff-banded Rails (*Rallus philippensis*), which share the aviary floor, have been observed on one occasion to prey on newly-laid eggs.

CAPTIVE REPRODUCTION

Captive reproduction of *H.boydii* has previously been documented on only a single occasion, also at Wildworld (Cermak, 1986). Unconfirmed accounts have also been reported from Cardwell Reptile Park (T. Gordon, pers. comm.). The results of the captive breeding programme for *H.boydii* at Wildworld are summarised in Table 1. The results are presented in more detail below.

The breeding pair of dragons maintained at Wildworld were originally collected from the Carbine Tablelands, north of Julatten in the 1980's. The female was adult when collected and was initially housed in an outdoor display. She failed to settle in, constantly rubbing her snout on the wire and refusing to feed and her condition gradually deteriorated until she was moved into the Rainforest Aviary when her condition improved. The male, being considerably smaller and

possibly still immature was housed in the outdoor display where he adjusted without any problem. The display measures 1.1 x 1.1 x 2.1m, receives morning sunlight and is furnished with many upright climbing perches and live plants. This enclosure is also home to a pair of Pink-tongued Skinks (*Hemisphaeriodon gerrardii*).

On 27 September 1991, it was decided to move the original male (which at this time appeared to be mature) in with the female. The pair was frequently monitored for any antagonistic behaviours, but none have been witnessed. Twice a week the lizards are checked and fed pink mice and cockroaches, which are offered as a supplement to the natural food present in the aviary (earthworms, cockroaches and crickets). The female has also been observed feeding on raw meat dusted with Insectivore Mix (Wombaroo Products), which is prepared for the rails.

On 29 January 1992, the female was found in an emaciated state with her snout and front limbs covered with soil. The soil in the aviary was dug up and a clutch of five eggs was found at the rear of the aviary in a shallow depression. All of the eggs were dehydrated and partly decomposed and it was presumed that they were the result of an earlier nest that went undetected; however, the newly laid clutch was not located.

Six months later on the 29th July the same female produced a clutch of three eggs. She was first observed at 12pm digging a shallow depression under the overhang of a rotten log. Sixty minutes later she had completed depositing the eggs and had commenced filling the depression with soil and leaf litter. The eggs were recovered for artificial incubation. During the removal of the eggs, the female attempted to defend the site with repeated lunges with mount agape. The eggs were placed in damp peat moss and incubated at a room temperature that varied from 27-32°C. Although such temperatures are acceptable for incubation of most reptile eggs, it was feared that they may be detrimental for the development of the embryos, in light of the habitat occupied by these dragons.

The eggs were checked twice weekly throughout incubation and the substrate moistened when required. On 1st October, after an incubation time of 63 days, one of the eggs was discovered slit, with the tip of the neonate's snout protruding. This was left until the following morning when it appeared to be unchanged. The incision was lengthened to verify the condition of the neonate, however, it was dead. The remaining two eggs were both manually slit and it was established that both neonates appeared to be fully developed and alive. At 8am the following morning both dragons were still attached to their eggs, so it was decided to tie off and remove the umbilicus as it seemed to have dried up and ceased functioning. Within 48 hours both juveniles had grown progressively weaker and died. It was concluded that the high incubation temperatures may have contributed to their accelerated development and presumed early hatching.

On 21 October, five well-developed eggs were unearthed, again buried in dry soil in the rear of the aviary. Compared to the previous clutch these eggs were significantly larger and more turgid. After 26 days, on 16 November, a perfectly developed hatchling with no trace of unabsorbed yolk was discovered active within the container. The following morning revealed a further three animals, with one individual still absorbing its yolk. All juveniles were extremely alert and active, showing no hesitation in biting an approaching hand. The fifth egg still looked healthy and was left for another three days. On the fourth day a juvenile Pink-tongue Skink was introduced to the container in the hope that it may promote hatching via the stimulus of outside movement. Overnight the egg was pipped, but the neonate failed to emerge and subsequently died. Like the other dragons, this animal appeared perfectly developed.

Upon discovery of this clutch the female dragon was checked to assess her condition and was found to be gravid again. To ensure collection of the eggs when deposited, a small temporary enclosure was constructed within the aviary to house the female. During the 15 days prior to depositing five eggs, she scratched numerous test holes in an attempt to locate a suitable site. On 5 November, she laid her eggs from a perch approximately 70cm from the ground, indicating

that she had failed to locate a suitable site for oviposition. All eggs were dehydrated and were placed in a container with near saturated moss. Two eggs died within the first 8 days. The remaining eggs were again subjected to high temperatures (28-32.5°C) for a number of days but continued to develop until 6 January 1993 when, after 62 days, they were found partly collapsed and hard. They were opened to reveal dead full-term neonates. Once again, it was suspected that the high temperatures may have contributed to their deaths.

On 24 December 1992, (49 days after the previous clutch), the collapsed condition of the female again indicated that another clutch may have been laid, although the eggs were not located.

It is thought that during 1993 four clutches were laid on 29 July, 7 September, 7 October and 4 November. However, only the first clutch was located, the four eggs were left to incubate in the aviary. Upon completion of egg laying, the female was observed positioning the eggs within the depression with her snout, at times quite roughly. When satisfied with the positioning of the eggs, soil was scratched over them using her front limbs and compacted using her snout and front limbs. A wire cage lined with shade cloth was placed over the site to protect the eggs from any disturbance by the birds and rats which occasionally entered the aviary. Prior to oviposition, the presence of eggs was obvious by the lizard's bulging abdomen and this was confirmed by palpation. Twice daily observations were carried out in the hope of catching her in the process of egg deposition. The period elapsing between suspected egg deposition dates were 41, 30 and 29 days respectively. The male was observed displaying to the female immediately after the 7 October oviposition, which possibly resulted in a mating and subsequent laying of the clutch on 4 November.

Activity increased significantly nearing oviposition, with the female constantly digging test holes in search of a suitable nesting site. During the early morning it was not unusual to find her out in the open in full sunlight, perched on a limb or on the wire, presumably basking. This would obviously assist with egg development, although she was never seen in the open during the day when the temperatures were higher.

During the incubation of the 29 July clutch, daytime soil temperatures ranged from 19-26°C. The egg closest to the surface was periodically found slightly exposed, presumably due to the expansion of the developing eggs pushing the top egg closer to the surface and was subsequently covered with a layer of soil.

Table 1. Incubation times, temperatures and hatchling sizes for *H.boydii* hatched at Wildworld. Note: All eggs produced by a single pair of *H.boydii*.

Date laid	Egg Nos.	Inc. time (days)	Inc. temp. (°C)	Hatchling SVL (mm)	Hatchling Tot. Length (mm)	Notes
29/7/92	1	63	27-32	35	95	Died in egg
	2	63	27-32	36	102	Died within 48 hours
	3	63	27-32	37	104	Died within 48 hours
Unknown	1	-	-	40	108	Died in egg 21/11/92
5/11/92	1	62	28-32.5	40	108	Died full term in egg
	2	62	28-32.5	38	103	Died full term in egg
29/7/93	1	99	19-26	39	105	
	2	99	19-26	42	115	
	3	99	19-26	42	116	

On 8 November, after 99 days incubation, three of the four eggs hatched, the remaining egg apparently having died mid-way through incubation. Two hatchlings were fully developed,

absorbing all evidence of yolk before emerging. The third individual spent nearly 24 hours within the egg before leaving. This individual was unable to absorb its yolk bolus completely, with half of it dropping off a day after hatching and was weaker than the other two. It refused to feed and drink and died after 18 days. The other two animals thrived, feeding only three days after hatching on small cockroaches, slaters and earthworms either left in a bowl or from forceps. Water was readily accepted from the spray bottle on a daily basis.

CARE OF YOUNG

The four individuals that hatched around 16 November, 1992 were kept together in a plastic container (60 x 38 x 40cm) covered with a shade cloth top and furnished with a multi forked branch for perching. A small water bowl was supplied, although water was readily accepted from a spray bottle and none of the animals have ever been observed drinking from the water bowl. Feeding commenced within two days of hatching. Peat moss was initially used as a substrate; however, to facilitate feeding, the peat moss was replaced with paper towels. All dragons are now readily accepting a variety of invertebrates (termites, slaters, crickets, earthworms and cockroaches) on a daily basis.

On 5 December one lizard had changed to a dark brown colouring, remaining motionless on the floor of the container and was disinclined to feed. When placed in another container it quickly resumed its normal behaviour suggesting that it may have been intimidated by its co-inhabitants. Fourteen days later another individual was subjected to intimidation and was also separated. The remaining two dragons were housed together until 26 September 1993 when a larger enclosure was constructed to house them. Shortly after their introduction to this enclosure the smaller animal showed signs of intimidation and was returned to its original cage. All animals have since been sexed as males.

The containers are regularly moved outside into filtered sunlight to provide access to ultra-violet radiation, despite the fact that no conscious effort to bask in both wild (Torr, 1993) or captive animals (with the exception of gravid animals pers. obs.) has been recorded. If exposed to temperatures above the low 30's, signs of heat stress including crouching on the floor of the cage or amongst ground cover, changing to dark colours and panting or rapid breathing are exhibited.

On 13 February 1993, the first animal isolated was seen to have developed a noticeable hump over its pelvic region, suggesting that it may have developed rickets. This lizard was consuming a diet of nothing but crickets and it was assumed that this predisposed the animal to the deformity. To rectify this problem further efforts were made to vary the diet. Small meals, other than crickets, were moved around in front of the lizard with a length of wire to stimulate a feeding response (this method later became commonly used during normal feeding times). This proved futile, so between attempts crickets dusted with D.C.P. powder were offered to maintain the lizard's condition. Nothing was taken for a time so the animal was gently force-fed small meal items. Avi-vite (Aviary Pharmaceuticals) powder was introduced to both water bowls and spray bottles as a supplement. Access to sunlight was also increased and within a couple of weeks small cockroaches were beginning to be taken voluntarily. Earthworms were also accepted, as was the occasional cricket. In approximately two months the deformity had subsided into an almost indistinguishable hump.

One of the dragons has since died, but the remaining three are all still doing well and growing at a steady rate. The two individuals from the second clutch started off well, feeding and drinking without hesitation. However, at three months of age, both deteriorated dramatically and died within a week of each other. Autopsies revealed that both had died from a bacterial gut infection, possibly contracted from a batch of worms that had been collected from the overflow ponds from the crocodile enclosures.

CONCLUSION

H.boydii appears to exhibit similar reactions to captivity and to share similar captive requirements with its southern congener H.spinipes. Both species have been observed to produce multiple clutches in captivity with three and possibly four clutches laid in 1992 and 1993 respectively by *H.boydii* in this report and double and triple clutches in a single season being recorded for captive *H.spinipes* (P. Harlow, pers. comm.). Multiple clutching also occurs in wild H.boydii (G. Torr, pers. comm.) and *H.spinipes* (A. Manning, pers. comm.). Multiple clutching by captive *Hypsilurus* is probably the result of two factors; regular feeding and increased social contact.

The regular feeding regime provided for captive *Hypsilurus* would compensate for any loss of condition from regular egg development, thus maintaining sufficient fat stores for continual egg production. The female in this report feeds virtually up to within a week of oviposition, indicating a need to maintain adequate fat stores. Animals in the wild may not have the same access to food and, hence, the intake may not always be sufficient for the production of multiple clutches. However, the rigours of egg development and stress from egg laying could affect the long-term health of the animal.

Additionally, animals kept within confined quarters would presumably come in contact more regularly, consequently increasing the chances of copulation shortly after oviposition. Lizards in the wild may not come into contact as frequently as captive animals, minimising the likelihood of copulation and, consequently, the number of clutches laid in a season. However, the home ranges of male *H.boydii* are relatively small and frequently contain the home ranges of one or more females, so this consideration may not be important (Torr, 1993).

Altitudinal influences may also have an effect on the frequency of reproduction (G. Torr, pers. comm.). The lower temperatures at higher altitudes may slow the development of the eggs and so lengthen the gestation periods. However, to counteract this, gravid animals may bask more in order to raise body temperatures to levels necessary for egg production. Feeding opportunities for highland populations of *Hypsilurus* may also be reduced by the cooler weather conditions, limiting food intake enough to produce fat stores adequate for only a single clutch in one season. These considerations are currently under investigation in *H.boydii* (G. Torr, pers. comm.).

As seen from the observations in this report, maintaining eggs at lower temperatures has achieved better results than with artificial incubation at higher temperatures. This would relate to the cool, shaded rainforests that this species inhabits. The lower temperatures appear to assist with the proper development of the embryo and the growth of the egg.

Those eggs that were incubated naturally (at lower temperatures) nearly doubled in size, compared to the minimal growth of eggs artificially incubated at higher temperatures.

Incubation temperature also seems to have a bearing on the health of the neonates. The smaller size of eggs incubated at high temperatures appears to restrict development, perhaps explaining the repeated deaths within the egg prior to and during hatching. Dehydration of the smaller eggs, due to little egg growth at higher incubation temperatures, may be a factor affecting hatching success. Hatchlings from eggs incubated at lower temperatures emerged stronger and fractionally larger in size, and fed within days of hatching. It would appear that incubation periods are longer in *H.boydii* than in *H.spinipes* when incubated at optimum temperatures though as shown in Table 1 incubation periods vary considerably with differing temperatures.

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ADDENDUM

On 8 October 1994 the female *H.boydii* laid a clutch of seven eggs, her largest clutch to date. The eggs measured an average length of 23.5mm and an average width of 14.3mm. The eggs were incubated in an airconditioned room with a temperature range from 21-24°*C. Two eggs containing embryos died some two months into incubation. The remaining five eggs hatched after 99-101 days and all five neonates are presently feeding regularly and growing well.*

Average measurements taken of the five dragons on 8 February 1995 (20-22 days after hatching) were:
SVL = 44mm
Total Length = 122mm

GREEN AND GOLDEN BELL FROG MORTALITY AT THE HOMEBUSH BAY OLYMPIC SITE

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INTRODUCTION

Having experienced a dry start to the 94/95 summer, many NSW frogs appeared slow to commence breeding. Sightings during Frog Week (first week of November) were down substantially and the dry period continued on into December. However, by January, rains had come to coastal NSW and frog activity was very evident.

As frogs move around in search of a mate and place to breed, individuals can be lost to premature mortality. If the animal has reproduced, the loss to the species is only the single life. In this case, the endangered Green and Golden Bell frog (*Litoria aurea*) was the tragic victim. However, the loss to this species was exponential as this account concerns a gravid female.

INCIDENT

On January 3rd of this year, heavy rain fell over Sydney much of the day and throughout the night. At 10:30pm, a local resident and WIRES volunteer, Brendon Neily, was driving south along Hill Road in Homebush Bay (future site of the 2000 Olympics). After passing Bennelong Road, he noticed several frogs hopping across the road ahead and some run over so he stopped to investigate further.

The mobile frogs and a dead one were identified as the common Striped Marsh frog (*Limnodynastes peroni*). The other eight road kills, however, appeared to be *Litoria aurea*. At least two of these were facing west - away from the brickpit (which is a well known *L.aurea* population site). The others had been jostled from their original positions so their direction of movement could not be determined. The identities of seven of the eight could not be independently confirmed since the animals were too damaged to be removed from the bitumen and their remains were gone the next day. It is the eighth frog which more dramatically illustrates the consequences which often occur when wildlife and automobile must share the same habitat.

The vehicle just ahead of Brendon's struck a frog about 250 metres south of Bennelong Road turnoff and Brendon pulled over to check the animal (see map). This one, also heading west, was clearly a Green and Golden Bell frog. She was still alive, but her vent area and legs were crushed. Clearly visible through her ruptured skin were masses of eggs. Brendon placed the frog in a plastic bag and stored it in his freezer until it could be transported to the Australian Museum. He also notified a friend in NSW National Parks and Wildlife Service of the circumstances on Hill Road that night.

The following night (January 4th), Brendon asked me, as an active member of the Frog and Tadpole Study Group, to accompany him to the site. Conditions were dry and approximately 20°C. No road kills were present and only six or so *Limnodynastes peroni* were seen sitting on the bitumen or roadside lawn. Sound recordings of seven species of frogs were made, those being *Limnodynastes peroni* (in their several hundreds), *L.tasmaniensis* (five), *Crinia signifera* (dozens), *Litoria dentata* (approx. 10) and *L.aurea* (only one). It is believed that two other calls on the tape were those of *Litoria peroni* (less than four) and *L.tyleri* (less than four). The disturbed habitat immediate to the road kills consists mostly of weeds, various grasses and some transient wetland. (Two weeks later, the same spot was visited again and not only was the water gone, not a single frog of any species was seen or heard calling). The only trees to be seen are mangroves which follow the path of Haslam's Creek. Hill Road is fenced along both sides with barbed wire and on the eastern side (the brickpit side), signs are posted warning of fines for dumping garbage.

Subsequently, the gravid frog was delivered to the Museum and registered as specimen number AMR146883. I counted the eggs using a dissecting microscope. Present were tiny white follicles, tiny red follicles and larger dark eggs without "vegetal" poles, some being slightly shrivelled. I estimated these three types at about 1,500; however, the exact count was based on the number of mature eggs only as identified by their "animal" and "vegetal" poles. The female measured 76.7 mm (snout to vent) and contained 2,486 mature eggs. It is possible that there may have been a few eggs left on the bitumen but Brendan couldn't see any when he retrieved the animal.

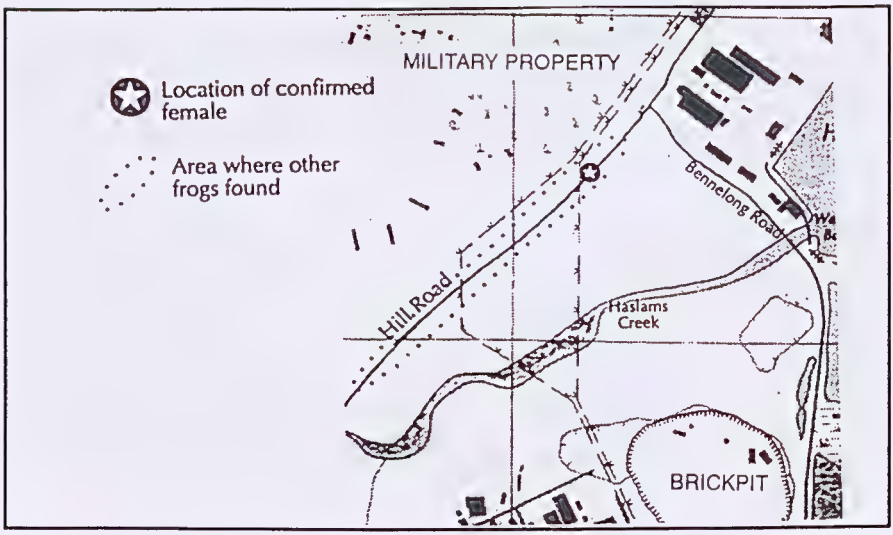
Since January 4th, neither Brendon nor myself has observed any other road kills. However, at the end of January, substantial rains fell again. A frog researcher was working in the area and confirmed five more adult *Litoria aurea's* killed on the same stretch of Hill Road.

DISCUSSION/RECOMMENDATIONS

Because the early January rains were the first good falls since the start of the normal breeding season, *Litoria aurea* may have been especially active at that time. Water levels in the transient wetlands west of Hill Road were very high and extended beyond the military's fenceline onto normally dry lawn (mostly kikuyu grass). Although there should have been sufficient water accumulated in the brickpit (difficult to check given the security afforded the area), frogs were apparently crossing Hill Road heading away from the open area on the eastern side (and the brickpit further east) and towards the transient wetland west of the road. (The one *Litoria aurea* tape-recorded was in the transient wetland close to the fenceline).

The location of the road kills raises some important questions. The first is the "migratory" and territory requirements of this species. Where was this female's starting point and intended destination? A barrier of brackish water (Haslams Creek) separates the known population in the brickpit from the stretch of road where this female was killed (Figure 1). Therefore, at least three possibilities remain to be verified: a) that *Litoria aurea* is capable of covering a sizeable distance connected with having a large territory requirement; b) that the species has the ability to tolerate brackish water; and/or c) that the area along Hill Road and eastward to the brickpit has not been adequately surveyed.

Figure 1. Map of the Homebush Bay area.



If this female was a member of the brickpit population, it is likely that she crossed Haslams Creek to reach Hill Road. To do so, either the species has a limited tolerance to brackish water or the surface of the slow moving creek was covered by a layer of fresh water due to the excessive rain and runoff during that period. Likewise, the volume of fresh water entering the creek may have neutralised the Ph level. It has also been recently discovered by researchers that a short stretch of Haslam's Creek has been so heavily silted that the water flow measures a mere 30cm across during low tide. It would be worthwhile to establish whether Haslams Creek is actually a barrier or not.

In addition to the scientific questions, there is still the dilemma over development versus the protection of endangered species. The number of adult Green and Golden Bell frogs in the brickpit is estimated at only 50-100 individuals while the entire Homebush Bay area may harbour only 100-200 adults (Greer, 1994). The entire population from known sites in NSW is estimated at only 500 adults (White, 1995). It has been confirmed that one gravid female and five other adults were killed in January. It is possible that some or all of the other seven January 3rd road kills were *L.aurea* as well. In a worse case scenario, this would represent 13 to 26% of the entire brickpit population or 6.5 to 13% of the overall Bay population killed in two nights of heavy breeding activity. At the very least, the confirmed road kills represent 6 to 12% of the brickpit population or 3 to 6% of the area adults overall.

Mortality caused by such a meagre instant in time as the passing of a car should be considered easily avoidable. It may be necessary to redirect vehicles during breeding activity of the Green and Golden Bell frog. Alternatively, the roads could remain open during breeding season but the speed limit could be temporarily lowered, cars restricted to one lane in each direction, and prominent signage displayed to warn drivers about avoiding frogs crossing the road. Such restrictions on traffic would only be necessary after dark on rainy nights during the summer ... not such a terrible inconvenience for us but terribly important for the Homebush Bay frogs.

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I would like to thank Brendon Neily for invoking my assistance when one of our frog species came under threat. I'd also like to thank Dr Allen Greer, Arthur White and Michele Christie for their important facts and viewpoints.

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A COMPARISON OF THREE LITTERS IN THE SHINGLEBACK LIZARD, *TRACHYDOSAURUS RUGOSUS*

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The Shingleback lizard, *Trachydosaurus rugosus*, is one of the most distinctive species of skink found in a wide variety of habitats from dry sclerophyll forests to hummock grasslands, chenopod shrublands and sparsely vegetated coastal dunes (Wilson & Knowles 1988).

This note is a comparison of three litters of captive *T.rugosus*. Specimens were housed in an outdoor area 6.0m x 4.0m in Bendigo, Victoria. Food consisted of fruit and vegetables, tinned dog food, soaked puppy chow, insects when available, flowers (including rose petals) and some vitamin supplements.

Female #A has been in my collection for a number of years. This female is a uniform black colour with yellow flecks. On 8th March 1991, Female #A gave birth to two juveniles, colouration was that of the mother. The juveniles were of approximately equal size, weight and colouration. Juveniles were tentatively sexed based on the observation that males have a broader head and more rounded tail in comparison to females which have a more slender head and straighter tail. Both the juveniles possessed characteristics of the male gender.

Female #B came into my collection on 13th March 1991, and was noted to be conspicuously gravid. The colouration of this female is cream ventrally and brown to black above with a cream dorsal stripe along the length of the back. Female #B gave birth to four young on 25th March 1991 and these were noted as having the same colouration to that of the female parent. The young were sexed as two males and two females; the females had noticeably longer and narrow heads.

Female #C has also been in my collection for a number of years and gave birth to three juveniles on the 23rd March 1993. The colouration of the mother and juveniles was similar to litter #B.

Data (mass, SVL) on each of the three litters is presented in Table 1.

Table 1: Data for each litter and the female parent

LITTER	MASS (g)	SVL (mm)	LITTER	MASS (g)	SVL (mm)	LITTER	MASS (g)	SVL (mm)
female #A	705	310	female #B	425	300	female #C	60	136
juv. #A.1	135	172	juv. #B.1	55	148	juv. #C.1	60	147
juv. #A.2	130	169	juv. #B.2	55	148	juv. #C.2	50	148
			juv. #B.3	50	142	juv. #C.3		
			juv. #B.4	50	146			

Mating activity has been observed in spring where paired lizards are usually found in close association with each other over a period of several weeks (Bull 1987). The male grasps the female by the head, neck or shoulder with his mouth during copulation (pers. obs.). It is common during this mating period to see males following females (Bull 1987) or two males hissing at each other in combat (pers. obs.). Gestation period is established at 150 days in the field (Bourne 1981) and 119 to 125 days in captivity (Greer 1989) with live births taking place in March. Litter sizes vary between one and three (Greer 1989, Cogger 1986) and rarely four (Wilson & Knowles 1988, Bourne 1981).

It is interesting to note that females #A and #B despite their similar SVL's produced litters of two and four respectively. Notice the 2.5 fold difference in the mass of the juveniles of these litters (Table 1). This would seem to indicate a trade-off between juvenile mass and litter size.

Figure 1. Female A and young

Figure 2. Female B and young

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A NEW NORTHERN LIMIT FOR THE STRIPED LEGLESS LIZARD, *DELMA IMPAR*

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The Striped Legless Lizard, *Delma impar*, is a rare species that has apparently suffered a marked reduction in distribution and abundance during the last hundred years (Coulson, 1990) and is regarded as nationally vulnerable (Cogger *et al.*, 1993). While the species is the subject of ongoing research in Victoria and the Australian Capital Territory (Coulson, 1990; Kutt, 1993; Osborne *et al.*, 1993), apparently peripheral populations of the species in South Australia and New South Wales have received little attention (Cogger *et al.*, 1993). Shea (1991, 1993) cites known records from New South Wales, the northernmost of which is from Sutton (Jenkins and Bartell, 1980). A previous record from Pokolbin (Swan, 1990) is based on misidentification (Shea, 1991).

The following is an account of two recent sightings from the vicinity of Goulburn, NSW in 1992 and 1994. These are the northernmost reported records and the first records from NSW in over a decade.

At approximately 0830 hrs on 21 August 1992, while surveying the herpetofauna of a friend's property approximately 4.5km SE Goulburn on the Windellama Road (34°47'S 149°44'E), a subadult *Delma impar* was found sheltering beneath a concrete slab (*ca.* 75 x 50 x 7cm) resting on soil in long grass. The lizard was torpid, tightly entwined amongst grass roots (*Phalaris*), and was apparently overwintering. A heavy cover of frost was present at the time, and the air temperature was approximately 4°C. On being warmed in my hands, the lizard became extremely active and emitted several sharp squeaks. It had an original tail, was approximately 150mm total length and had a boldly marked pattern similar to that pictured by Ehmann (1992). The lizard was released at the site of capture.

A subsequent visit to this site on 8 January 1993 by the author, W. Osborne and K. Kukolic did not reveal any *D. impar.*

However, in early January 1994, the owners of the property informed me that they had found a second specimen of *D. impar* active on the back verandah of the house at approximately 1530 hours on 2 January 1994. The weather was hot, with temperatures reaching approximately 35°C. They described the lizard as being "extremely active and sort of flipping about and (it) made a squeaky sound", about 150mm long (total length) and strongly striped like the first specimen. Although the accompanying photograph was inadequate for species identification, and a second species of *Delma*, *D. inornata*, may also occur in the area (K. Kukolic, *pers. comm.*), I have no doubt from their description that the lizard was *Delma impar.*

The habitat at the Goulburn locality is similar to that at known *D. impar* localities in the ACT (W. Osborne, K. Kukolic. *pers. comm.*), which are naturally treeless native tussock grasslands. The site from which the first specimen came is quite heavily grazed exotic pasture, with 30% ground cover of *Phalaris aquatica*, Yorkshire fog grass *Holcus* sp., *Vulpia* sp., *Bromus mollis, Paspalum* sp. and *Stipa bigeniculata*, and is only 150m away from typical *D. impar* habitat on an adjoining property. Upslope from this site, and close to the second site is grazed open native tussock grassland, predominantly (50 - 60%) *Stipa bigeniculata, Danthonia* sp., *Vulpia* sp. and *Bromus mollis*, on a substrate littered with loose quartz and dark igneous rock shards.

Further surveys of these sites and the surrounding area using pitfall traps (Osborne *et al.*, 1993) are required to ascertain the extent and density of this population.

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HERPETOLOGICAL NOTES

FURTHER OBSERVATIONS OF COMMUNAL HIBERNATION IN THE EASTERN SNAKE-NECKED TURTLE (*CHELODINA LONGICOLLIS*)

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Observations on two hibernation sites of the Eastern Snake-Necked Turtle, *Chelodina longicollis*, have been published by Green (1994). This is an update on those observations at Gunbower Island and the channel off Lake Boort in Victoria.

The lagoon at Gunbower Island had been searched for turtles from 1991 to 1993, with *C.longicollis* being found only under one semi-hollow log. During the winter of 1994, this same log contained three *C.longicollis*. About 100m south of this log one other *C.longicollis* was found between two logs. 15m to the north of the original log, there were a number of small logs which contained a further eight *C.longicollis*. On this occasion the turtles were found predominately in the mud between logs or partly under and beside a log..

This area of the island consists of several small lagoons which depend on rain for their existence, and Gunbower Creek and the Murray River are approximately 2km to the south and north respectively. These turtles had not previously been captured at this hibernation site. None of the turtles recorded, since the start of these observations in 1991, was found in 1994. This may be a further indicator that *C.longicollis* has long range terrestrial movements as described by Kennett & Georges (1990).

The second hibernation site off Lake Boort, contained 5 live and three dead *C.longicollis* in 1994. Since 1991 (excluding 1992), I have found dead turtle remains (N=6), primarily the shell, in the channel. Occasionally the live turtles have limbs missing or the flesh removed leaving exposed bones. There are many water rat burrows in the embankment and trails leading to the water, indicating the possibility of the rats preying on the hibernating turtles.

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Figure 1: Shallow lagoon on Gunbower Island, hibernation site of *Chelodina longicollis*. Note the turtles in the foreground to the left.

PREDATION BY A MULGA SNAKE *PSEUDECHIS AUSTRALIS* ON A WESTERN BROWN SNAKE *PSEUDONAJA NUCHALIS*

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A road-killed mulga snake *Pseudechis australis* was found on Roopena Station Eyre Peninsula (32°44'S, 137° 25'E) in December 1992. On closer examination, the tail of the dead Western brown snake *Pseudonaja nuchalis* was protruding from the stomach of the *P.australis*, which had been ruptured by the accident and the anterior and midbody portion of the *P.nuchalis* was protruding from the mouth of the *P.australis*.

Clearly the *P.australis* had been swallowing the *P.nuchalis*, tail first at the time it was killed.

Snakes in the diet of *P.australis* have been reported by Shine 1987 who records 20 snakes in a total of 135 prey items. This poses the question of how *P.australis* escapes the effects of the venoms from its venomous snake prey which would inevitably bite back. Mirtschin and Davis 1982, report that the venom of other elapids has no effect on *P.australis*. One of us (PJM) has observed a number of cases of live *P.nuchalis* being fed to *P.australis* in captivity, biting *P.australis* with no apparent effects. Thurn *et al* (1993) have shown that the serum from both *P.australis* and *Pseudechis porphyriacus* does confer protection against *Notechis scutatus* venoms. This level of protection against both their own venom and that of other species is not apparently restricted to the *Pseudechis* genus. Flachsenberger *et al* (in press) and Hains (1993) have shown that serums from *Notechis scutatus* and *Pseudonaja textilis* confer protection against the action of a range of Australian and some exotic snake venoms.

Figure 1. The Mulga snake with the partially eaten Western brown snake.

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RANGE EXTENSIONS FOR SOME SNAKES IN WESTERN AUSTRALIA

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Echiopsis curta is a small to medium-sized robust snake previously recorded on the mid-west coast north to the Greenough River by Storr et al (1986). On 16 May 1993 while spotlighting for nocturnal reptiles Gary Davies and I collected a single adult snake active on an unsealed road at 21km south of Kalbarri (27°52'S, 114°10'E). The surrounding vegetation consisted of road verge tall open Acacia sp. with emergent Mallee over grasses with numerous limestone exposures. This record represents a minor northerly range extension of about 80km to near the Murchison River.

The herpetofauna of the Exmouth region is extremely rich and diverse with 114 species and subspecies previously recorded (Storr and Hanlon, 1980). Recent taxonomic revisions and the discovery of new species in the area have increased this number.

On 14 June 1993, during a field trip, Greg Harold, Robert Browne-Cooper and I excavated an adult *Vermicella bimaculata* beneath a decaying stump on the crest of a red sandridge at 2km west of Bullara Homestead (22°41'S, 114°01'E). This record represents a substantial northerly extension of range from the nearest record at Shark Bay. A number of reptile species have broken distributions along the west coast (Storr *et al*, 1983) and the Exmouth region is notable for apparent isolated populations of reptile species that are more widespread in other parts of the state. Examples are *Diplodactylus mitchelli, Ctenophorus clayi* and *Ctenotus calurus*. To these could be added *Demansia rufescens* which is widespread in the Pilbara region being previously recorded south to near the Cane River. On 21 May 1994 Brian Bush found a road-killed adult female *D.rufescens* while spotlighting at Learmonth (22°15'S, 114°05'E). The surrounding habitat was undulating Triodia sandplain interspersed with numerous stony areas.

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FURTHER INSTANCES OF NOCTURNAL ACTIVITY IN AGAMIDS AND VARANIDS

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INTRODUCTION

Nocturnal behaviour has been documented for the following agamids: *Amphibolurus gilberti, Diporiphora bilineata, Diporiphora magna* (Bedford, 1991), *Tympanocryptis lineata, Diporiphora sp.* (Fyfe, 1981) and *Moloch horridus* (Niejalke, 1994).

Records of nocturnal activity for Australian varanids appear to be scant with a report of two *Varanus glebopalma* active after dark in the Kimberleys (Shea, *et. al.,* 1988). Table 1 sets out additional sightings for *A.gilberti* and *D.bilineata* in northern Australia and two sightings of *Pogona vitticeps* in western New South Wales. An observation on an adult *Varanus spenceri* is also included.

DISCUSSION

Niejalke (1994) suggests that nocturnal activity may be associated with a natural (e.g. flooding) or human induced disturbance. In the case of *V.spenceri* recent heavy showers may have disturbed the monitor at rest, although the immediate plain was not flooded. When first sighted the monitor was alert and positioned in an upright stance.

Both sightings of P.vitticeps coincided with excessively high daytime temperatures. Such conditions may serve to restrict activity to cooler periods and perhaps moonlight is sufficient for agamids to visually detect invertebrate prey which are both active and abundant on such evenings (pers.obs.).

Table 1

Date	Time hrs	Species	Weather Conditions	Location	Habitat	Notes
19/11/92	19:50	*Amphibolurus gilberti*	*Fine conditions, no breeze, moonlit 26°C	Flinders Hwy, Qld 62km east of Mt Isa	Rocky, triodia covered slope	Sub-adult male, 120mm SVL
18/09/90	21:15	*Diporiphora bilineata*	Fine conditions, slight breeze, moonlit 24°C	Harvey Range Rd,Qld 42km west of Townsville	Slope of dry sclerophyll woodland. Speargrass understory.	Adult female, 65mm SVL
19/01/88	20:35	*Pogona vitticeps*	Fine conditions, slight breeze, moonlit 31°C	Fairmount Station NSW 45km SE of Wilcannia	Mulga woodland plain with chenopod understory.	Adult male active on secondary road
20/01/88	22:30	*Pogona vitticeps*	As above 27°C	As above	Interdune of mallee/triodia association.	Adult female active on secondary road
18/11/92	22:37	*Varanus spenceri*	Heavy rain showers, dark night 23°C	Tablelands Hwy, NT Vicinity of Alroy Downs Station, Barkly Tableland	Cracking blacksoil plain of astrebla grassland.	Adult 1.2m TL

*Recorded within 24 hours after rain SVL = snout vent length TL = total length

That the majority of sightings have occurred on road surfaces may be due to driver headlight illumination. Such lighting may induce agamids to venture onto road surfaces where potential prey is easier to detect and more concentrated (Bedford, 1991). I also witnessed an adult *Eremiascincus richardsonii* near Whyalla, South Australia in early January 1994 run on to the bitumen from the surrounding scrub to consume a ghost cricket crawling in front of my car in view of the headlights.

The *Pogona* and *Moloch* sightings (Niejalke, 1994) from southern xeric Australia tend to indicate that nocturnal activity amongst agamids may be widespread and not only confined to the tropics. However such activity has only infrequently been reported throughout the continent.

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NOTES ON REPRODUCTION IN CAPTIVE *RHINOPLOCEPHALUS BICOLOR* (SERPENTES: ELAPIDAE)

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Rhinoplocephalus bicolor is a small elapid snake endemic to humid and sub-humid habitats in the lower south-west of Western Australia. Although not uncommon within its natural distribution, few published data are available concerning its reproductive biology.

On 24 January 1994 Brad Maryan and I uncovered a gravid female *R.bicolor* within a disused stick-ant nest (*Iridomyrmex conifer*). The locality was ten kilometres north of Denmark (34°56'S, 117°21'E) in a lowland seasonal sedge swamp, sparsely populated with *Melaleuca* spp. with a eucalypt woodland periphery.

This female was housed in an all-glass terrarium kept indoors and exposed to naturally fluctuating temperatures of 20°C to 34°C.

Three young were born on 12 March 1994. For snout-vent length and weight of young and mother, measured eighteen hours after birth, see Figure 1.

Shine (1986) determined it to be live-bearing with litter sizes of one to five. He mentions "a remarkable ontogenetic shift in colour", and this is consistent with the present record. The neonates are a pale powder-blue and much paler than the dark greyish-brown mother.

This ontogenetic shift in colour may only occur in individuals from the extreme south-west of its range. During discussions with Brian Bush and Brad Maryan, both of whom have located *R.bicolor* in the wild, we determined that the ontogeny observed in this study and reported by Shine (*supra cit*) is not consistent throughout its range. We suspect it is a result of a cooler, more humid climate. Bush (pers. comm.) describes an adult (36cm) specimen from the eastern part of its distribution, Coomalbidgup (33°27'S, 121°23'E), 60 kilometres west of Esperance, as "very pale bluish-grey with a narrow, pale orange vertebral stripe and lower flanks of similar

colour". Maryan (pers. comm.) describes two adults as follows: a) from Stirling Range (34°24'S, 118°02'E), "pale powder blue" and b) from Two Peoples Bay (34°57'S, 118°11'E), "very pale grey" similar to the neonates in this sample. Storr *et al* (1986:139) illustrate two extremes in colour in this species, the paler of which is from the warmer and less humid eastern extremity of its range. The neonates in this record have a similar colouration.

Figure 1. Measurements of snout-vent length and weight of mother and neonatal *Rhinoplocephalus bicolor.*

Neonate	SVL (mm)	Weight (gm)
A	148	3.00
B	151	2.88
C	145	2.66
Mean	148	2.85
Female	365	19.46

Relative Clutch Mass 43.9%

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MICROSYMPATRY BETWEEN TWO SPECIES OF FOSSORIAL SKINK ON THE NEW SOUTH WALES SOUTH COAST

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Two species of fossorial skink are known to occur on the NSW South Coast. *Nannoscincus maccoyi*, chiefly found in the south-eastern highland areas of NSW and Victoria, has an outlier population in the Shoalhaven/ Illawarra region of coastal NSW (Ehmann, 1992). Site records for this population have mainly been from the escarpment and ranges, such as Mount Kiera (Swan, 1990), Jamberoo (Cogger, 1992) and West Cambewarra (Daly, pers comm). The common name of Highlands forest skink suggested by Ehmann (1992) reflects the upland moist forest habitat typical of the species. The second species, *Saiphos equalis* (Three-toed skink), is found in rainforest, sclerophyll forest and heath in the coastal lowlands and ranges from south-eastern Queensland to the Shoalhaven/Illawarra region on the NSW South Coast (Ehmann,1992). Recent fauna survey work for the NSW National Parks and Wildlife Service in the Comerong Island Nature Reserve (34°53 S 150°44 E) recorded both species. This finding is significant as a new habitat record for *N.maccoyi*, a southern range extension for *S.equalis,* and the first record of microsympatry between these two species.

Comerong Island is a low sand island situated between the Shoalhaven River and Crookhaven River deltas on the NSW South Coast, 10 kilometres east of Nowra and 150 kilometres south of Sydney. The island was actually a sandy peninsula until the excavation of a canal linking the

rivers in 1822. The western half of the island has been cleared for dairy farming. The remnant native vegetation in the eastern half is protected as a Nature Reserve of 660 hectares. The vegetation types present in the Reserve include foredune succession, open eucalypt forest, littoral rainforest, estuarine saltmarsh, and mangrove woodland. The open eucalypt forest is dominated by blackbutt (*Eucalyptus pilularis*) and bangalay (*E. botryoides*), with an understorey including old man banksia (*Banksia serrata*), coastal bearded heath (*Leucopogon parviflorus*) and sweet pittosporum (*Pittosporum undulatum*), and ground cover of bracken (*Pteridium esculentum*), blady grass (*Imperata cylindrica*) and spiny-headed mat-rush (*Lomandra longifolia*). The littoral rainforest area is one of the largest remaining on the NSW South Coast (NPWS, 1994) and contains species such as lillypilly (*Acmena smithii*), corkwood (*Guioa semiglauca*), native laurel (*Cryptocarya glaucescens*), sweet pittosporum (*Pittosporum undulatum*), coast banksia (*Banksia integrifolia*), brush muttonwood (*Rapanea howittiana*) and cabbage palm (*Livistona australis*).

Search methods for fossorial skinks involved turning over logs and raking through leaf litter. Twenty nine *N. maccoyi* and eleven *S.equalis* were found in the littoral rainforest and open eucalypt forest areas in a search effort totalling 7 hours over September to November 1994. Most records were of animals sheltering under decaying banksia logs. *N. maccoyi* were recorded at 13 sites, and *S. equalis* at 7 sites.

The record of *N. maccoyi* from Comerong Island is the first in NSW from forest on coastal sand dunes. The Comerong Island Nature Reserve contains one of the last remaining areas of littoral rainforest on the NSW South Coast. It is likely that *N. maccoyi* had a more extensive lowland distribution prior to the clearing of these coastal forests.

The record of *S. equalis* from Comerong Island extends the known range of this species eight kilometres past the previous southern limit at Seven Mile Beach National Park (Murphy, 1994). The species was found to be common on Comerong Island, in contrast to its rarity at Seven Mile Beach.

The distribution of the two species on Comerong Island was microsympatric. Both species were recorded under a single piece of fallen timber at five different sites. Pitfall lines (consisting of six traps joined by a twenty metre drift fence) were set at two of these sites, and were open for seven days in November. Eight *N.maccoyi* and two *S. equalis* were captured in one trapline, and one of each species in the other.

The discovery of these two species on Comerong Island raises the question of how they partition the fossorial skink niche between themselves. Swan (1990) reported the diet of *N.maccoyi as* small insects and that of *S. equalis* as anthropods. The snout-vent lengths of 32 *N. maccoyi* and 13 *S. equalis* caught during the study were measured. *N. maccoyi* averaged 45mm SVL (range 28 - 58mm) and *S. equalis* 69mm SVL (range 60 - 76mm). These sizes are comparable to those given by Swan (1990) and Cogger (1992). The difference in body size between the two species may indicate that they take different-sized prey items and thus avoid direct competition for prey. Another possibility is that they have different activity patterns.

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ROAD KILL PREDATION BY THE BLACKHEADED PYTHON *(ASPIDITES MELANOCEPHALUS)*

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The literature suggests that many Australian snakes are opportunistic feeders (Shine 1991, and references cited therein). Consumption of road killed prey has been observed in at least two species of snake. The Fresh Water Snake *(Tropidonophis mairii)* was observed to feed on frogs which had been run over by passing vehicles on a floodplain in the Northern Territory (Bedford 1991a). Similarly King Brown Snakes *(Pseudechis australis)* have been noted to eat road killed goannas (Bedford 1991b).

On 20th December 1994, at 20:00 hr a Black Headed Python *(Aspidites melanocephalus)* (1500mm snout-vent length (SVL)) was observed eating a road killed and very flattened spotted pygmy goanna *(Varanus scalaris)* of about 250mm (SVL). Because of the hazards involved in feeding on the road, the snake was moved and the prey item removed from its mouth. The goanna appeared to have been dead for about one day, and had probably been run over by many vehicles. It was in the middle of the road, about 2km east of the MacArthur River mine turn-off, 42km west of Booroloola, NT. The lizard was very desiccated and stiff, congealed blood adhering the animal to the bitumen. When found the python had pried the head of the goanna from the road and was attempting to eat it. The goanna was estimated to be about 10cm wide and 1-2cm high and would have made a difficult meal for the snake (see Fig. 1). This behaviour by *A.melanocephalus* has been observed on another occasion although the species of dead Varanid was not determined (T. Sullivan, pers. comm.).

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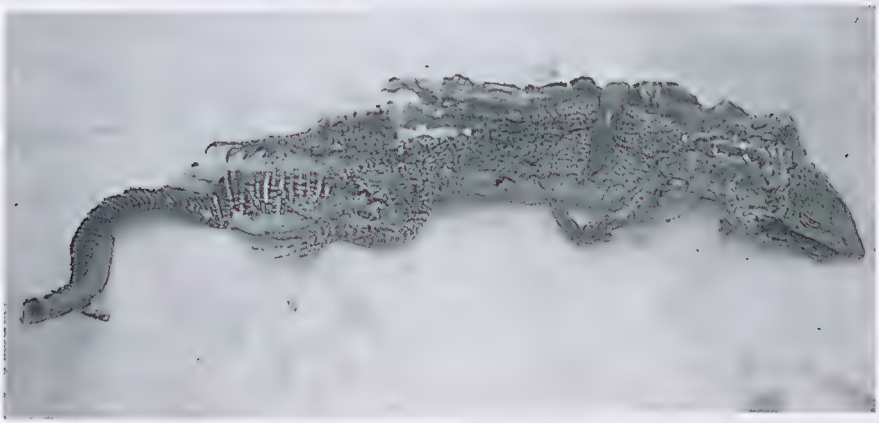
Figure 1. The road killed *Varanus scalaris.*



OBSERVATIONS OF CANNIBALISM BY PYGMY COPPERHEADS (*AUSTRELAPS LABIALIS*)

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Copperheads (*Austrelaps* sp.) are generally thought to be cannibalistic (Shine, 1991). Schwaner (1985) claims that Pygmy Copperheads (*Austrelaps labialis*) are known predators of other snakes, and this accounts for the low numbers of immature Tiger Snakes (*Notechis ater niger*) observed on the islets in Pelican Lagoon, Kangaroo Island, SA. This note describes both captive and field observations of cannibalism by *A.labialis* on Kangaroo Island, South Australia.

On 7 November 1993 at 10.00 cst a large specimen of *A.labialis*, kept in a pit, was observed consuming a smaller specimen of the same species (SVL 557mm, tail 128mm, 103gms and 394mm, 81mm and 32gms respectively). The pit measured 6 metres by 5 metres, and held 3 other specimens of *A.labialis*. When this behaviour was first observed only 30mm of the smaller specimen was protruding from the mouth of the larger. When the larger specimen was picked up by the tail it quickly regurgitated its prey which was very listless and died 7 days later.

The captive condition in which these Pygmy Copperheads were held may have contributed to the observed behaviour. On 12 October 1994, however, an observation of cannibalism at Brownlow, Kangaroo Island (35°40'S, 137°37'E), confirmed that this is natural behaviour for this species. In this case a "large bulky" *A.labialis* was seen consuming another, described as "not particularly small" (M. Iversen, pers. comm.). These two *A.labialis* were estimated to be approx. 700mm and 450mm total length, respectively.

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Schwaner, T.D. 1985. Population Structure of Black Tiger Snakes, *Notechis ater niger,* on offshore islands of South Australia, pp 35-46. In Grigg, G.C., Shine, R., Ehmann, H. (eds). Biology of Australasian Frogs and Reptiles. Royal Zool. Soc. NSW Sydney.

BOOK REVIEW

Handbook of Salamanders. The Salamanders of the United States, of Canada, and of Lower California, by Sherman C. Bishop.
Handbook of Snakes of the United States and Canada. 2 Vols. by Albert H. Wright and Anna A. Wright.

Published by Comstock Publishing Associates (Cornell University Press), Ithaca, New York.

Between 1943 and 1957, as part of the Handbooks of American Natural History series, five books covering the salamanders, frogs and toads, turtles and tortoises, lizards and snakes of the United States and Canada were published by the Comstock Publishing Company, in total 3516 pages in six volumes (snakes were covered in two volumes). The first and last of these handbooks, the Handbook of Salamanders and Handbook of Snakes, have now been reprinted in paperback by the original publishers as part of the Comstock Classic Handbook series.

The herpetological volumes in the Handbook series are scarce in Australian libraries, probably due to a combination of the very different nature of the Australian herpetofauna and Australian parochialism. However, they deserve a wider readership in this country, both as reference works to the North American herpetofauna, and as examples of a type of encyclopedic treatment sadly lacking any equivalent in the Australian literature. Each volume includes keys, maps, line drawings, photographic illustrations and descriptions of morphology and coloration for each

species and subspecies for identification purposes. In this respect they resemble Cogger's *Reptiles and Amphibians of Australia*, although there are some major differences. Among positive features, the Handbook series gives individual accounts to subspecies, the descriptions are generally more extensive and precise, and the photographic illustrations are more closely associated with the relevant text. On the negative side, the photographs are all black and white (a reflection of technology at the time of original publication).

However, the Handbooks are more than just identification guides. Additional to the morphological descriptions for each species and subspecies are detailed, fully referenced accounts of habitat preferences, reproduction, diet and other field observations, many from the personal experiences of the authors. The last in the series, the Handbook of Snakes, is the most detailed in this respect, and is packed with quotations from the literature and field notes, most with dates and locality. The field notes in particular are very readable and often raise a smile. For example (p.126):

> "May 8, 1942, at night, on one of the San Diegan's favourite herpetological collecting roads: Perhaps 3 miles west of Benson's Dry Lake, we saw on the road in our headlights a small moving snake and picked up a *Sonora o.annulata* and very soon a second one. They look white in the car light. They are small, hence not hard to collect because they have some distance to go across the road. It was one of the forms desired. But a car approached in the dark. Charles Shaw and his friends. "That you, Dr Wright?" One way for introductions! Incidentally they discovered we had a flat tyre and repaired it for us. Herpetological Samaritans!"

Some individual species accounts extend over more than eight pages. Compare this with the accounts available in Australian publications of similar style, which rarely give more than a paragraph of ecological information, present unreferenced summary statements, and rarely have species accounts extending over more than a page.

It is this additional information that gives these Handbooks their continued freshness and relevance despite a changing taxonomy and subsequent ecological research. Original explicitly-stated data has no use-by date. A measure of the importance of a reference text is the frequency of reprinting. Despite the lack of revision, the Handbook of Salamanders was reprinted in 1967, and again in the present form. There has been no other work of the same scope published to replace it. In contrast, the Handbook of Snakes was reprinted for the seventh time in 1989, only five years before the present edition, despite the appearance of other less comprehensive works on the snakes of North America in the years since its first publication.

The current facsimile reprints in the Comstock Classic Handbook series are of high quality. Although the paperback format may not have the same resilience as the earlier hardback editions, the reprints are more likely to find a place on the reference shelf than in a field situation. Both reprints are printed on acid-free paper for permanency, although the photographs possibly suffer slightly from the change to non-glossy paper. A new foreword is added to each book, by Edmund D. Brodie in the Handbook of Salamanders, and Jonathan A. Campbell in the Handbook of Snakes, giving an updated nomenclature for the taxa covered, a necessity given four or five decades of systematic refinement. Campbell's foreword also gives biographical information on the authors.

When first published, only the text and illustrations of the Handbook of Snakes were included in the two volumes published by Comstock. The detailed bibliography was subsequently privately printed as a third volume by the authors. The reprint similarly only covers the original two volumes. However, a facsimile of Volume III was published in 1979 by the Society for the Study of Amphibians and Reptiles, and forms a valuable companion to the Comstock Classic reprints.

I look forward to the completion of the series with reprints of the lizard, turtle and frog volumes.

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BOOK REVIEW

Das Tierreich. Part 109. Familia Gekkonidae (Reptilia, Sauria) Part I Australia and Oceania.
by A.M. Bauer in collaboration with K. Henle.
Published by Walter de Gruyter, Berlin & New York, 1994. DM598 (approximately A$550)

Das Tierreich (The Animal Kingdom) is an ambitious long-term project by German biologists and publishers to produce a classification of all animal groups. The first part appeared in 1896, and the volume here reviewed is the 110th (the first part was unnumbered). The project is nowhere near complete. Among reptiles, some large families, such as the Scincidae, have yet to be the subject of Das Tierreich volumes, while others, such as the Gekkonidae, have been the subject of several parts. The current Das Tierreich on geckos is the third attempt to produce a gecko checklist in this series (previous Gekkonidae volumes were produced by Franz Werner in 1912 and Heinz Wermuth in 1965), and appeared almost simultaneously with a checklist of the Gekkonidae independently produced by the International Gecko Society (Kluge, 1994).

Checklists are inherently derivative publications, attempts to synthesise, summarise and reconcile differences of opinion in the available literature. As summaries, they are valuable as introductions to the literature for taxonomists and non-taxonomically minded biologists alike, particularly for those learning about a group for the first time. However, they vary greatly in quality, depending on the familiarity of their author with the subject and the completeness and accuracy of their coverage of pertinent literature. They are also, by their very nature, rapidly out-of-date. In the thirty years since the previous Das Tierreich volume on the Gekkonidae, there have been a many changes to gecko systematics and nomenclature. This is particularly evident in Australia and New Zealand, where there has been a vast amount of recent revisionary work published. This work continues - although the present work, by Aaron Bauer and Klaus Henle, two herpetologists with long-term interests in gecko systematics and ecology, was published only last year, six new species, one resurrected species, and one new genus of gecko have been described among the Australian fauna alone (Couper *et al.*, 1993; Couper & Gregson, 1994) since their manuscript was accepted for publication.

With over 900 species of gecko worldwide, a single volume covering gecko classification and literature is now out of the question. Aaron Bauer has instead opted to divide the family into geographic groups. This first part covers the geckos of Australia, New Zealand, New Guinea, New Caledonia and the numerous archipelagos of the Pacific Ocean, except for the Philippines and Japan and their territories, and the eastern Pacific islands biogeographically associated with the Americas.

The phylogenetic coverage is limited to the limbed geckos (the traditional family Gekkonidae), and does not include the pygopodid lizards which some authors have identified as part of the gecko lineage. Even so, the volume covers 173 species and 12 additional subspecies, in 23 genera. From Australia and its territories, Bauer and Henle report 103 species in 15 genera. In comparison, Cogger (1992) records 97 species in 17 genera. The difference is due to recognition of two additional genera (*Lucasium* and *Underwoodisaurus*) by Cogger and six additional species (*Cyrtodactylus sadleiri, Diplodactylus furcosus, Gehyra fenestra, Gehyra kimberleyi, Heteronotia planiceps* and *Pseudothecadactylus cavaticus*) by Bauer and Henle.

The first consideration by any potential purchaser of this book must be the price. With a recommended price of DM598 (roughly $550), the next question will be is the book worth it? After all, at this price, each of the 318 pages (including the 12 pages of introduction) is worth over $1.70. Certainly, the book is well bound, and printed on acid-free paper for permanency. However, this in itself doesn't justify the price. It is the contents of the book which are important.

The volume includes keys to all genera, species and subspecies of gecko in the region, spot distribution maps derived from "museum records and from published sources based primarily

on museum records", synonymies for all genera, species and subspecies, and a list of additional references for each taxon. At the end of the volume is a list of species arranged according to their distribution on island groups and Australian states.

Considering each of these in turn, the keys are clearly presented dichotomous keys. Most are derived from previously published keys (Cogger, 1992; Storr *et al.*, 1990; Bauer, 1990), and work as successfully as the originals: well in some cases, poorly in others.

Spot distribution maps are generally preferable to broad "black blob" style maps, as used by most field guides, in that they indicate definite localities rather than a presumption of overall distribution. The spot distribution maps in this volume are of variable quality, depending on the recency and completeness of taxonomic revisions. Some include very dubious localities. For example, the map for *Christinus marmoratus* includes localities from coastal NSW, which were not listed by Swan (1990) the apparent source of other NSW localities; *Nephrurus milii* (*Underwoodisaurus milii* for those more familiar with Cogger's nomenclature) has localities in the interior and north coast of WA, distant from the distribution given by Storr *et al.* (1990), and also a dot in central Qld, not corresponding to the locality-based distribution given by Ingram & Raven (1991); the map for *Oedura marmorata* includes localities along the southern edge of the continent; the map for *Oedura robusta* includes a locality near Canberra, as does Swan (1990), although this does not correspond with Swan's written southern limit of Myall Creek. No specific sources of information are given for the maps, and hence it is not possible to determine the source of any questionable localities. Certainly, there is no indication that the authors have checked questionable localities.

At the other extreme, many maps are incomplete. For example, *Rhynchoedura ornata* occurs through much of arid Australia, not just across the central part. Bauer and Henle list references that give localities in the unmapped parts of the range such as the Kimberley and Eyre Peninsula, but have not made use of these references. The map for *Oedura marmorata* excludes most of the Western Australian distribution in failing to show localities in the Pilbara and Gascoyne districts. The map for *Gehyra pilbara* provides a very restricted distribution, although the most recent revisor, Glen Storr, regarded the species as extending across Western Australia to the Northern Territory (Storr *et al.*, 1990).

Curiously, the map for *Gehyra variegata* identifies three "introduced populations" within the known natural range of the species, but gives no reason for this claim. Presumably it is based on the disjuct occurrence of some chromosomal races, but in the absence of explanation, how does one tell?

The synonymies provided are thorough, and the most complete I have yet seen. The species synonymies include not just the usual lists of junior synonyms, but are chresonymies, presenting in chronological order all usages of the species name and its synonyms, all combinations of species and generic names, and even all usages of the same combinations in any publication of nomenclatural significance or frequent reference. Added to the end of each account is an additional list of relevant references, both taxonomic and biological, arranged by topic. In this, it resembles the checklist of Australian reptiles by Cogger *et al.* (1983), but is much more thorough. Certainly, there were a number of references of which I was unaware.

Inevitably, however, any checklist is only as good as the literature it is based on, and there are some errors in the synonymies. Some discrepancies between works are noted, but others are overlooked. For example, Bauer & Henle note the discrepancy in *Phyllurus cornutus* (now *Saltuarius cornutus*) between Cogger's (1979) identification of syntypes (several primary type specimens) and his later (Cogger *et al.*, 1983) listing of only a single holotype (single primary type specimen). They follow Cogger *et al.* in listing only a holotype. However, it is clear from Ogilby's description that six specimens were used in describing the species. Cogger's later

listing of a holotype is incorrect (in fact under the Code of Zoological Nomenclature, such an incorrect assumption of holotype status qualifies as designation of a lectotype: Article 74b).

Similarly, Bauer and Henle follow Covacevich (1971) in listing a holotype for *Nephrurus levis* in the Queensland Museum. However, they did not notice the existence of a second type in the Macleay Museum, referred to in the early literature (Anon, 1886; Lucas & Frost, 1896).

They follow previous checklists in identifying the holotype of *Gehyra punctata* lost. However, the holotype was rediscovered and re-examined by Storr (1982; pers. comm.), who used it to identify *Gehyra punctata* and *G. fenestra* as synonymous. Lacking this information, and concerned by the existence of several different chromosomal races within the range of *G. punctata,* Bauer and Henle follow previous usage and recognise the two species as distinct.

In some cases, their examination of the taxonomic literature revealed problems with the names currently accepted for species and subspecies. In most cases, they did not examine type specimens in museums, but merely noted the existence of the discrepancy (e.g., the placement of *Peripia torresiana* in the synonymy of *Gehyra baliola* disagreeing with subsequent restrictions on the distribution of *G. baliola*; similarly the questionable identity of *Gecko grayi* and *Perochirus mestoni*, regarded by most previous authors as synonymous with *Gehyra variegata*, but possibly synonymous with *Gehyra dubia*), leaving it to future workers to examine the type specimens and resolve the problem. However, in a few cases, they have made nomenclatural changes, and these I dispute.

Bauer and Henle resurrect *Phyllodactylus macrodactylus* Boulenger as the oldest available name for the eastern subspecies of *Christinus marmoratus*, displacing *Christinus marmoratus alexanderi*. They further note that *Phyllodactylus peronii* Fitzinger 1843, regarded by previous authors as an unavailable name, is available, stating "if one of the Kangaroo Island specimens of *P. peronii* Fitzinger 1843 is accepted as a lectotype, the Western Australian populations would remain as *Christinus marmoratus marmoratus* and the 2n = 36 chromosome form from eastern Australia would be referrable to *Christinus marmoratus peronii*". There are three problems with this. Firstly the name *peronii* pre-dates *marmoratus* by two years, and hence use of the name would give *Christinus peronii marmoratus* in the west and *Christinus peronii peronii* in the east, disrupting a previously stable nomenclature. Secondly, their recognition of *Phyllodactylus macrodactylus*, which has no locality associated, is based on colour pattern, and it is not indicated whether the type specimens were examined or just the description. Thus, there is no explicit justification for the change of names. Thirdly, any name changes in the eastern form are premature, as ongoing biochemical work indicates that *C. m. alexanderi* does not include all eastern populations (see also Storr, 1987).

Bauer and Henle also make changes in *Crenadactylus*. They state: "Günther (1875) restricted the type locality [of *Crenadactylus ocellatus*] to "Champion Bay, Houtman's Abrolhos, Western Australia". However, as typical specimens do not occur at this locality, the action is invalid (see Storr, 1978b)". They then resurrect *Diplodactylus bilineatus* Gray 1845 (type locality Houtman's Abrolhos), from the synonymy of *Crenadactylus ocellatus ocellatus* to replace *Crenadactylus ocellatus horni*, a name in wide use for the arid populations. Firstly, Günther did not restrict the type locality. His listing is merely of localities associated with British Museum specimens: Western Australia (locality for the type of *Crenadactylus ocellatus*), Houtman's Abrolhos (type locality for *Diplodactylus bilineatus*, which he regarded as only subspecifically distinct), and Champion Bay, locality for a later specimen collected by F.H. duBoulay. Secondly, the Abrolhos are inhabited by the nominate subspecies of *Crenadactylus ocellatus* (Storr *et al.*, 1990), and hence if the type locality is correct, *Diplodactylus bilineatus* (despite the name) is synonymous with this spotted subspecies, not the striped *C. o. horni*. Resolution of this problem requires more detailed work on morphological variation of the two subspecies and examination of type specimens, but the change in nomenclature proposed is premature.

They further note that *Diplodactylus jonathoni* Wells and Wellington is a senior synonym of *D. immaculatus* Storr, and that strict application of the rules of nomenclature would require use of the former name. However, as noted by Shea (1987), the holotype of *D. jonathoni* is a specimen of *D. steindachneri*, and does not agree with the definition of *D. jonathoni* provided by Wells and Wellington. Hence the problem disappears.

One final curious problematic name. Bauer and Henle follow previous workers in considering *Gecko dorreensis* a *nomen nudum* (name unaccompanied by a definition, and hence unidentifiable and unavailable). However, the name, proposed by Péron (1807) for a gecko collected on Bernier I. in Shark Bay by the Baudin Expedition of 1800-1804, is accompanied by a measurement, 10-13 cm (also given as 4-5 inches) which clearly differentiates it from the other lizards reported by Péron from the island, and hence the name is technically available. The size is reached by only two species of gecko on the island: *Nephrurus levis* and *Nephrurus milii* (Storr & Harold, 1978). The latter species was described 19 years after the Baudin Expedition's return, from a specimen collected by the Expedition from Shark Bay, and named after one of the officers of the expedition. It is likely that the gecko named by Péron *Gecko dorreensis* was the same specimen named *Phyllurus milii* after Péron's death. This type specimen is now lost, but Péron's name pre-dates the widely used name.

These comments and criticisms may seem to be nit-picking, but if zoologists accept a rigid Code controlling zoological nomenclature, they must abide by it. Two of the basic principles of the Code of Zoological Nomenclature are recognition of chronological priority and maintenance of a stable nomenclature. In fairness to the authors, these sorts of subjective opinions and errors are similarly common or even more common in other checklists, and at least here the arguments are usually explictly stated to allow an alternative argument.

The volume contains a number of typographical errors, suggesting that proof-reading may not have been especially thorough, a disturbing feature of a volume that is dependent on accuracy. For example: p. I: "appropraite"; p. II: "Gray, 1843" (rather than 1845); p. 2: "sacles"; p. 33: "norrower"; p. 78: "holotpye"; p. 135: "shoult"; p. 198: "Asutralia"; p. 211: "adeguately"; p. 225: "2992" (rather than 1992); p.283: "extripated".

These criticisms aside, to answer the question I first set: if you are after a reference work on the systematics and literature on the geckos of Australia and Oceania, particularly if you have access to a friendly librarian with a large budget, this is the top of the list. However, the price is way over the top for the material covered. If you're the average private herpetologist lacking institutional support and willing to settle for the cheaper, alternative, you can get Cogger's fifth edition (Cogger, 1992), his checklist (Cogger *et al.*, 1983), Bauer's carphodactyline gecko revision (Bauer, 1990) and Kluge's world gekkonid checklist (Kluge, 1993) together for less than half the same price, giving you much the same range of information together with photographs, on almost five times the number of pages. To my mind, the choice is simple.

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NOTES TO CONTRIBUTORS

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Boyd's Rainforest Dragon (*Hypsilurus boydii*) at Lake Eacham, Atherton Tablelands, Qld.
See paper on page 33. (photo: M. Anthony)

A male Eastern Water Dragon (*Physignathus lesueurii*) from east of Wagga Wagga.
See paper on page 22. (photo: T Annable)